



# RADIOLOGY

A MONTHLY JOURNAL DEVOTED TO CLINICAL RADIOLOGY AND ALLIED SCIENCES

Vol. 42

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No. 1

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# RADIOLOGY

A MONTHLY PUBLICATION DEVOTED TO CLINICAL RADIOLOGY AND ALLIED SCIENCES

PUBLISHED BY THE RADIOLOGICAL SOCIETY OF NORTH AMERICA

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## Bone Changes in Leprosy: A Clinical and Roentgenologic Study of 505 Cases<sup>1</sup>

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IT IS WELL KNOWN that there are two main types of leprosy, the lepromatous (formerly called cutaneous or nodular) and the neural, which differ widely in prognosis, pathology, and clinical manifestations. One of the important differences between the two types of the disease is the kind and extent of bone involvement. The usual and most remarkable bone changes are those of neurotrophic origin, which occur in the majority of neural cases and not in true lepromatous or nodular leprosy. Of an entirely different nature is the rarer and less conspicuous type of bone destruction seen in the lepromatous type of the disease. Most cases of neural and lepromatous leprosy sooner or later acquire lesions of the other type and thus become the mixed type, in which bone changes of both varieties occur.

From a review of the literature it appears that little has been written on the subject in the last fifteen years. The two outstanding contributions within that period are those of Chamberlain, Wayson, and Garland (1931) and Murdock and Hutter (1932). Most of the bone changes seen

by us have been described by other writers, but these have not reported such extensive bone destruction or made clear that certain bone changes correspond to certain types of the disease. Honeij (1917), for example, reported similar bone involvement in all types of leprosy, with bone absorption found as frequently in the nodular (lepromatous) type as in the neural. As long ago as 1911, Dyer and Hopkins, in Louisiana, were impressed by finding necrosis, atrophy, and absorption of digital bones confined practically exclusively to neural leprosy. This experience has continued unchanged at the National Leprosarium in the intercurrent years.

Before reporting upon our findings it may be well to emphasize the fact that, since the usual bone changes occurring in leprosy are neurogenic, they are similar to those found in other neurotrophic diseases. For example, atrophic absorption of the phalanges has been found in Raynaud's disease, syringomyelia, tabes dorsalis, and chronic injuries of the spinal cord or of the peripheral nerves. Furthermore, other diseases may produce bone lesions similar to those of leprosy, as, for example, osteomyelitis, diabetic gangrene,

<sup>1</sup> Accepted for publication in June 1943.

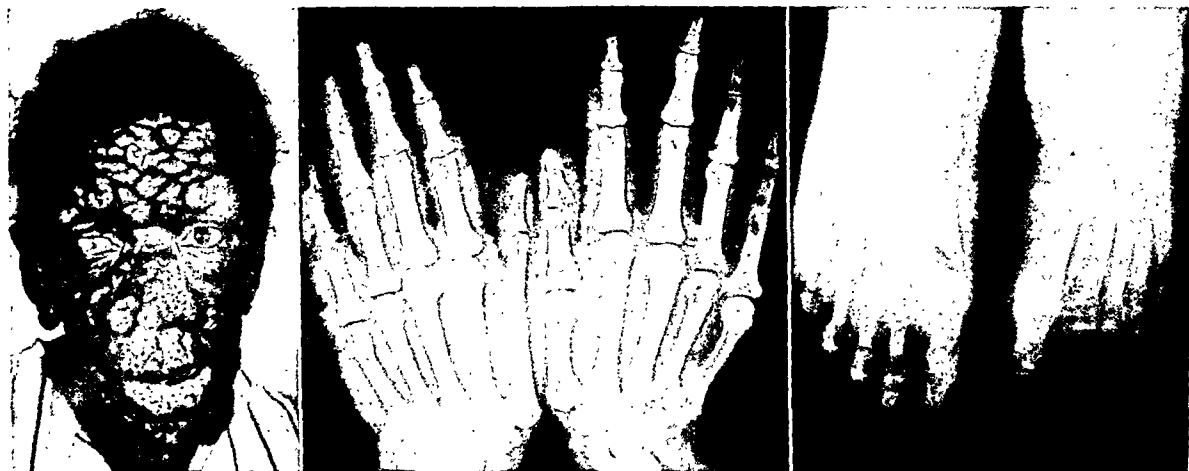


Fig. 1. Lepromatous leprosy of fifteen years' duration in a colored female, American, 42 years of age, showing leonine facies, leprous keratitis, and corneal opacities. Upper and lower limbs are also covered by extensive lepromatous nodulation and infiltration. There is no x-ray evidence of bone changes in hands or feet, the usual observation in lepromatous cases

gout, Buerger's disease, scleroderma, psoriasis, ainhum, frostbite, Boeck's sarcoid, tuberculosis, and syphilis. In addition, tabes may produce Charcot joints which occasionally involve the smaller articulations of the hands and feet with contractions which are indistinguishable from those of leprosy.

The present study is based upon the observation of 505 patients with all types of leprosy at the National Leprosarium. Of this number 340 were males and 165 females, a proportion of over 2 to 1. The ages on admission to the leprosarium varied from four to seventy-six years. The majority of the patients were between twenty and forty-five years of age.

The period of observation varied from several months to two and a half years; all patients in the leprosarium between July 1940 and January 1943 were included. The classification of the disease in the group under study is indicated in Table I: 47.7 per cent of the cases were of the mixed type, 31.7 per cent of the lepromatous type, 18.2 per cent of the neural type, and 2.4 per cent of the tuberculoid type. The table also gives the incidence of bone changes, as demonstrable roentgenographically, encountered in each type of the disease, as well as muscular atrophy and contracture of digits.

TABLE I: INCIDENCE OF BONE AND MUSCLE CHANGES IN LEPROSY

Types of Disease	Number of Cases	X-ray Bone Changes	Muscular Atrophy and Contracted Digits
Mixed type	241	79	66
Lepromatous type	160	9	0
Neural type	92	59	26
Tuberculoid type	12	0	1
Total	505	147	93

Bone changes of varying degrees were seen in roentgenograms of the hands or feet, or both, of 147 of the 505 patients, an incidence of 29 per cent. Bone changes occurred in only 9 of the 160 lepromatous cases, or 5.6 per cent. Fifty-nine of the neural cases showed definite bone lesions, which in many cases were extensive and of a mutilating nature. This is an incidence of 64 per cent for this form of the disease. Finally, of the 241 mixed cases, 79 or 33 per cent, showed bone involvement.

In addition, clinically and roentgenologically, it was found that 93 patients suffered from more or less muscular atrophy and digital contraction, in the extreme cases producing claw-hands and claw-feet. Although the majority of these patients had a combination of both neurotrophic and motor disabilities of the extremities,

many exhibited either bone absorption or muscular paralysis and contracture alone (Figs. 9 and 10). This exclusive involvement of either the motor or the neurotrophic nerve fibers in leprosy has not been reported elsewhere to the authors' knowledge. Hopkins (1928), it is true, observed in this institution that "the claw-hand of leprosy is a result of atrophy and contracture of the flexion mechanism, most marked when loss of bone is inconsiderable." It can now be added that the op-

tasks with only remnant stubs for fingers. This phenomenon is not easily explained but is probably dependent upon an unequal involvement of the neurotrophic and motor neurones. When the neurotrophic neurones are primarily attacked, the motor neurones seem to escape, and trauma to active fingers enhances bone absorption. When the motor neurones are principally involved, muscular atrophy and contractures protect immobile fingers from bone absorption.

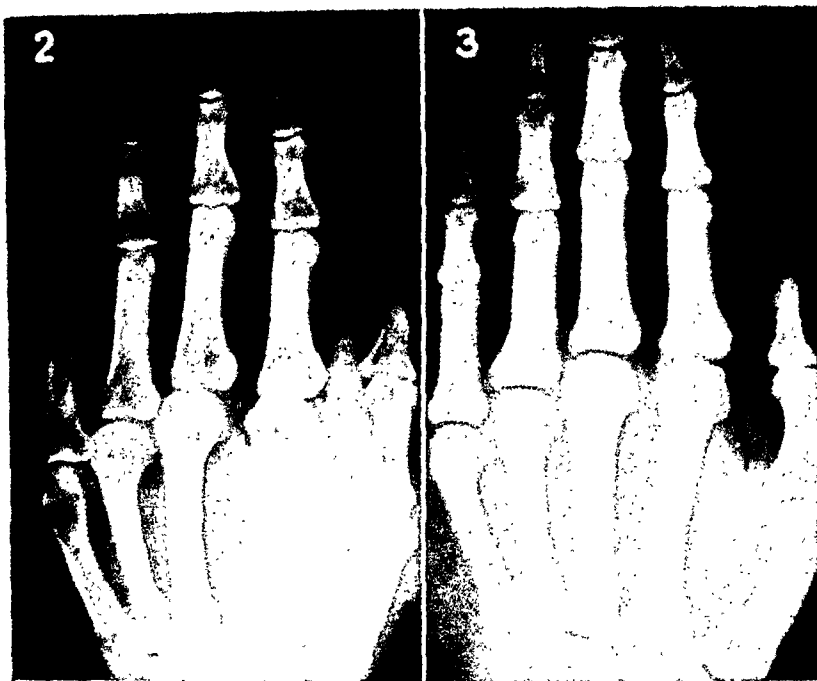


Fig. 2. Lepromatous leprosy of six years' duration in a male, Chinese, 64 years of age. Enlarged nutrient canals are seen in several phalanges.  
Fig. 3. Lepromatous leprosy of four years' duration in colored male, American, 34 years of age. There is a small cyst of the shaft of the proximal phalanx of the ring finger.

posite is equally true, that bone absorption is most marked when atrophy and contracture are inconsiderable.

Patients with claw-hands, muscular atrophy, and ankylosis of interphalangeal joints may be so disabled as to be dependent upon others to feed and dress them. Conversely, patients with extensive bone absorption of the fingers and little or no muscular atrophy have the function of the hands partially preserved. These patients are often able to feed themselves, dress, write, and perform other delicate manual

#### LEPROMATOUS LEPROSY

Lepromatous leprosy even in its advanced stage is usually free from bone lesions (Fig. 1). In our experience bone disease, if it does occur, is limited in extent and of little clinical significance. It is entirely different from the osseous absorption of neural leprosy. In the 9 lepromatous cases in our series in which bone disease was found, it consisted of enlarged nutrient canals in 4, cyst formation in 3, necrosis or osteomyelitis in 1, and periostitis in 1 (Figs. 2-5).

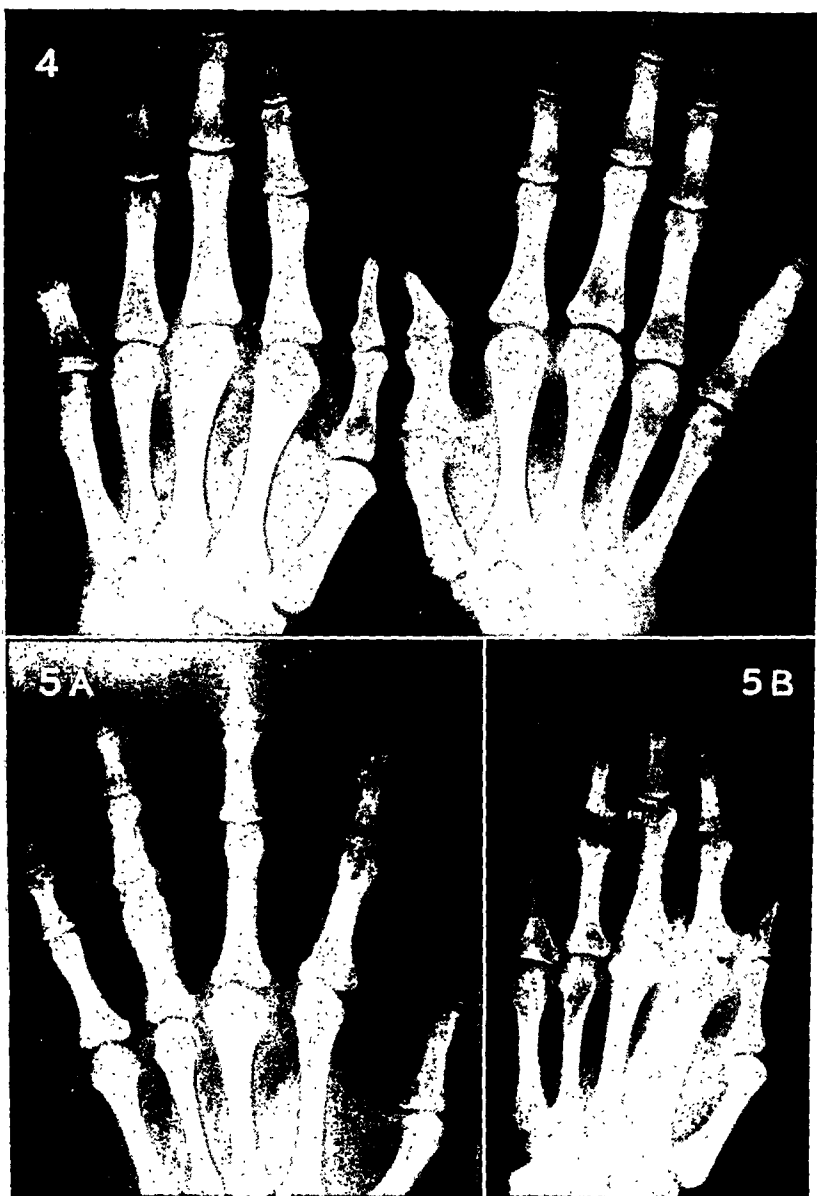


Fig. 4. Lepromatous leprosy of five years' duration in white male, American, 22 years of age. Note multiple cysts in phalanges and metacarpals of both hands. Smears made of material aspirated from a cyst show numerous acid-fast bacteria including many globi.

Fig. 5. Lepromatous leprosy, later becoming mixed, of seventeen years' duration in a male, Hawaiian, 22 years of age. A. Lepromatous stage: periostitis and osteomyelitis, presumably leprosy in origin, of the proximal phalanx of ring finger. There are also enlarged nutrient canals. B. Mixed stage, seven years later. Healing has been complete with little residual evidence of bone destruction. Notice beginning neurotrophic absorption of tuft of little finger.

The enlarged nutrient canals are considered to be produced by a leprosy infection of the nutrient vessels. Necrosis of bone is believed to result from interference with the blood circulation due to a leprosy endarteritis. It is primarily an aseptic necrosis. Fite (1941) reports the frequency of involvement of blood vessels in lepromatous leprosy. The endothelium is commonly infected, and a lepromatous growth into the lumen of a small vessel may be produced (Fig. 19). This condition may well lead to vascular occlusion with resultant necrosis.

#### NEURAL LEPROSY

The most important bone changes of leprosy are those found in neural leprosy. They are not due to the direct action of Hansen bacilli on the bones but to a remote nerve infection which causes secondary bone absorption of a neurotrophic nature. Hansen bacilli are rarely, if ever, encountered in the bone marrow of neural cases. Cass and Rishi (1934) found bone marrow smears negative for these organisms in 100 per cent of 48 neural cases, whereas 17 of 21 lepromatous cases gave positive findings.

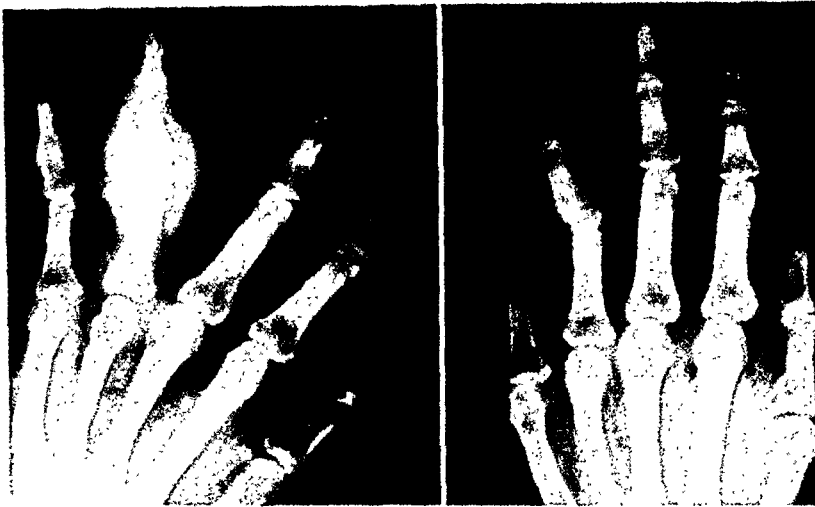


Fig. 6. Mixed leprosy of seven years' duration in male, Filipino, 42 years of age. The roentgenogram on the left shows osteomyelitis of the proximal phalanx of the ring finger, believed to be of leprosy origin. Ten months later (right) there was complete healing, with little osseous destruction.

Bone cysts are considered to be due to the direct action of Hansen bacilli infecting the medullary cavity. Needle puncture and aspiration of the cysts yield material rich in acid-fast bacilli and globi. These have been discovered, also, in bone marrow smears taken at necropsies from a large percentage of such cases at the National Leprosarium. It is conceivable that they multiply there to form lepromata. Occasionally these lepromata may grow sufficiently large to appear in roentgenograms as bone cysts. Direct infection with *Mycobacterium leprae* is probably responsible for some cases of osteomyelitis and periostitis.

The neurotrophic bone changes of nerve leprosy are found to consist of a slow and insensitive bone absorption. This spontaneous absorption of bone thins out or shortens the phalanges, metacarpals, and metatarsals. In the hands the process generally starts in the distal phalanges, causing slicing and nicking of the tufts, then a shortening of collar-button type, followed by gradual disappearance (Figs. 7 and 8). Next the middle phalanges are attacked. The bones seem to melt away, the proximal phalanges being the last to disappear (Fig. 10). In rare cases even the metacarpals are attacked, but the process seldom ascends higher (Fig. 11).

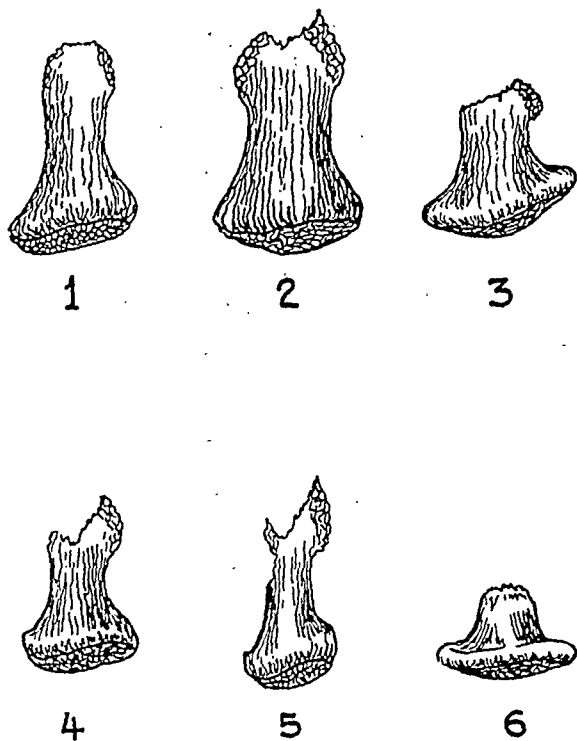


Fig. 7. Tracings of distal phalanges from neural and mixed cases, showing earliest types of bone absorption in the form of slicing and nicking and collar-button formation.

In the feet the absorptive process is apt to start in the shafts of the proximal phalanges or in the heads of the metatarsals (Figs. 14 and 15). The diaphyses of the phalanges become gradually thinned by the rarefying osteitis, so that eventually there is but a fine needle of bone left (Fig. 15). This condition of gradual erosion of the cortical portion of the bones has been aptly called a "concentric bone atrophy." During this process the medullary cavity disappears or becomes calcified. A complete disappearance of the involved bone is a frequent final outcome. In such cases the shortened toes are seen to override the shortened foot (Figs. 16 and 18). These toes are loosely connected to the foot by soft tissue only, but may still contain the two distal phalangeal bones. Spontaneous fractures are frequent, due to the trauma of weight-bearing on the insensitive diseased bones.

The metatarsal bones, unlike the metacarpals, are commonly involved beginning at their distal ends. During the process of

absorption, these bones become shortened, while their distal ends become pointed. The appearance produced can be likened to that of a stick of candy being sucked away (Figs. 15 and 18). The process rarely extends higher than the metatarsals, the tarsal bones and the lower ends of the tibia and fibula usually remaining intact.

The difference in the mode of onset of bone absorption in the hands and feet shows the importance of trauma as a contributing factor. In the hands the point of greatest stress and the site of the most repeated traumas is at the ends of the fingers. Constantly repeated strain is applied to the finger tips in touching, feeling, and grasping objects in one's environment. The prime function of the feet being weight-bearing, it is the ball of the foot which sustains the greatest pressure and traumas. It is not surprising, therefore, that it is the tips of the distal phalanges in the hands and the heads of the metatarsals and the diaphyses of the proximal phalanges in the feet which first undergo neuro-leprous bone degeneration and absorption.

In claw-hands the finger tips are protected from trauma, but the flexed interphalangeal joints are frequently bumped against hard objects. Roentgenograms of claw-hands show the effects of such trauma in frayed joint surfaces, erosions of articulating ends, mushrooming of the phalangeal bases, chipped-fractures into joints, and other evidence of destructive arthritis (Fig. 12). The ankylosis of claw-hands occurs principally in the interphalangeal joints, while the metacarpophalangeal articulations usually remain free and active.

Although larger joints remain comparatively free in neural leprosy, there may be either a fibrous or a bony ankylosis of the interphalangeal or the metacarpophalangeal and metatarsophalangeal articulations, or an abnormal relaxation of the joints (Fig. 14). Subluxations are not uncommon, especially in the feet. Painless disorganizing arthropathies are frequent in small joints (Fig. 14) and are not entirely wanting in the larger joints. We



Fig. 8. Neural leprosy of fourteen years' duration in white male, Mexican, 26 years of age. Early bone absorption in hands. Different stages of bone absorption limited to distal phalanges, from slight absorption of tufts to almost complete absorption of distal phalanx.

Fig. 9. Neural leprosy of nine years' duration in white female, American, 37 years of age. Extreme clawing of hands and muscular atrophy with very little bone absorption. There is great crippling of function.

Fig. 10. Neural leprosy of forty-one years' duration in white female, American, 60 years of age. Note almost complete absorption of phalanges and partial absorption of metacarpals. No muscular atrophy and some preservation of function of hands. Contrast with Figs. 9 and 12.



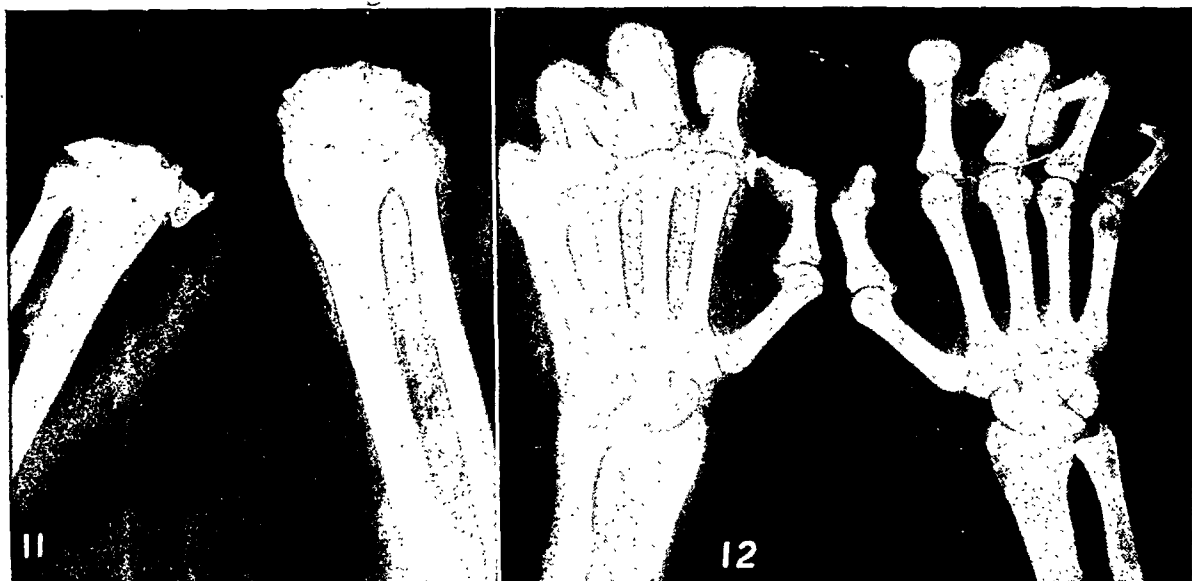


Fig. 11. Neural leprosy of thirty years' duration in white female, American, 53 years of age. Remarkable spontaneous absorption of bones of hands (mutilating leprosy). There have been no amputations in this case.

Fig. 12. Mixed leprosy of thirteen years' duration in white female, American, 38 years of age. Claw-hands with minimal bone absorption, showing destructive arthritis of interphalangeal joints and fracture of head of metacarpal. This is the result of trauma to crippled, insensitive hands.

have observed five typical Charcot joints of wrists and ankles in our cases, where syphilis could be excluded clinically and serologically (Fig. 13).

#### MIXED LEPROSY

The bone lesions of mixed cases partake of the nature of both the neural and lepromatous types. Of the bone changes in the 79 mixed cases the great majority were of neurotrophic type; only 25 showed osseous infection of lepromatous origin. The lepromatous type of bone involvement is more frequent in mixed than in lepromatous cases, since it is generally a late manifestation of leprosy. In the 25 cases in this series there were cystic degeneration, osteomyelitis, periostitis, enlarged nutrient canals, and occasionally a spindle-shaped leprosy dactylitis closely simulating that of tuberculosis or syphilis (Figs. 6 and 17). The neurotrophic bone lesions, especially in advanced cases, are often extensive and mutilating (Fig. 16).

#### EXPLANATION OF NEUROTROPHIC BONE CHANGES

The exact causative factor of bone absorption in neurotrophic leprosy is not

proved. It is considered to be the result of disturbance of the nutritional function of the affected nerves rather than of a faulty calcium and phosphorus metabolism.

In an earlier study at the National Leprosarium, Lemann, Liles, and Johansen (1927) analyzed the blood of 54 patients for calcium content and concluded that this bears no relationship to bone absorption in leprosy. Wooley and Ross (1931) confirm the findings of others that bone changes in leprosy are not dependent on total blood calcium. In their experience the calcium-phosphorus balance ratio also failed to explain these bone deficiencies. The average diffusible calcium was found to be lower, however, in patients with leprosy than in normal adult controls. These workers conclude that there may be a possible relationship between low diffusible calcium content of the blood and decalcification and bone absorption in leprosy.

In our experience a leprosy neuritis must be of sufficiently long duration and of an advanced stage, with degeneration and fibrosis of nerve fibers, before bone absorption takes place. We have seen repeated neural and mixed cases of several years'

duration with little or no bone change; we have not seen the rapidly developing and receding bone changes in youths reported elsewhere. It is true that our young population is proportionately small. Muscular atrophy and contractures of digits generally precede and often are present for several years before the onset of bone absorption in cases where the two conditions are combined.

Thus bone absorption in leprosy in our experience is a relatively late manifestation of the neural or mixed type of the disease. It does not occur in the purely nodular, cutaneous, or lepromatous type, where the nerve trunks are not affected. As a late manifestation it is always accompanied by other distinctive signs of neural leprosy. This fact is important from a differential diagnostic standpoint, since the early roentgenologic findings in the hands and feet are not so characteristic of neural leprosy as to be easily distinguishable from bone changes of other neurotrophic diseases of either the central or peripheral nervous system. The mutilating bone changes of advanced neuroleprosy are characteristic but of no special value in diagnosis, since the clinical manifestations then present offer no diagnostic difficulties.

#### SECONDARY INFECTION

In such a chronic disease as leprosy it is not surprising that secondary infection sooner or later supervenes to cloud the clinical and roentgenologic picture. Bone lesions due to secondary infection are common in all types of leprosy and are most frequent in the mixed type. Long-standing lepromatous or trophic ulcerations of the extremities offer a convenient portal of entry for pyogenic organisms, leading to the production of secondary osteomyelitis. Although it is our experience that chronic osteomyelitis in leprosy may be initiated by Hansen's bacillus, contamination by pyogenic invaders is the rule. We have found Hansen's bacillus in smears taken from osteomyelitic bones, even in neural cases, which shows its importance in such

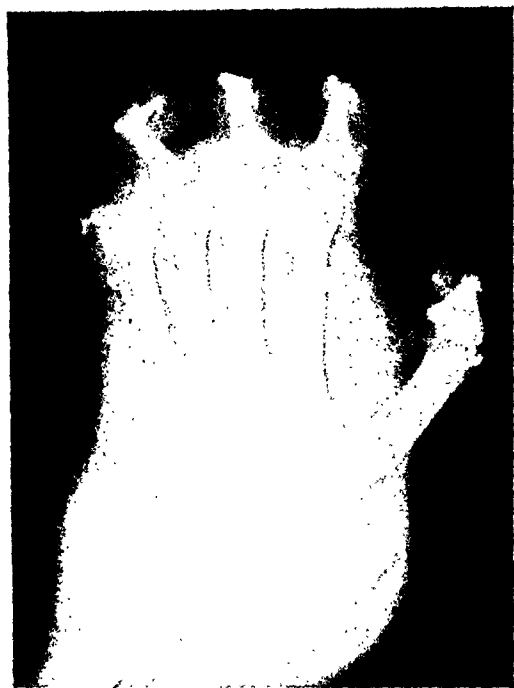


Fig. 13. Mixed leprosy of twenty years' duration in colored male, American, 36 years of age. Charcot wrist in a patient in whom syphilis was ruled out by history, clinical findings, and negative blood and cerebrospinal fluid serology. Note extensive neuroleprosy absorption of phalanges.

bone disease. Even when secondary invaders play a major role in the destructive process, it is felt that *Mycobacterium leprae* exerts a modifying influence on the osteomyelitis.

In roentgenograms seen side by side, lepromatous osteomyelitis is difficult to differentiate from pyogenic osteomyelitis. The rate of bone destruction is an important distinguishing point. In the pyogenic variety there is rapid destruction, with no regeneration. In leprosy osteomyelitis there is slow evolution, complete necrosis does not always supervene, and there may be regeneration of bone (Figs. 5 and 6).

Involvement of the nasal cartilages is a common late sequence of leprosy of the nasal mucosa. This is a frequent complication of lepromatous and mixed leprosy. The final crumbling of the cartilaginous nasal septum produces the typical saddling deformity of the nose so common in advanced stages of the disease. Disintegration of the bony septum is extremely rare. When it occurs, it is probably caused by

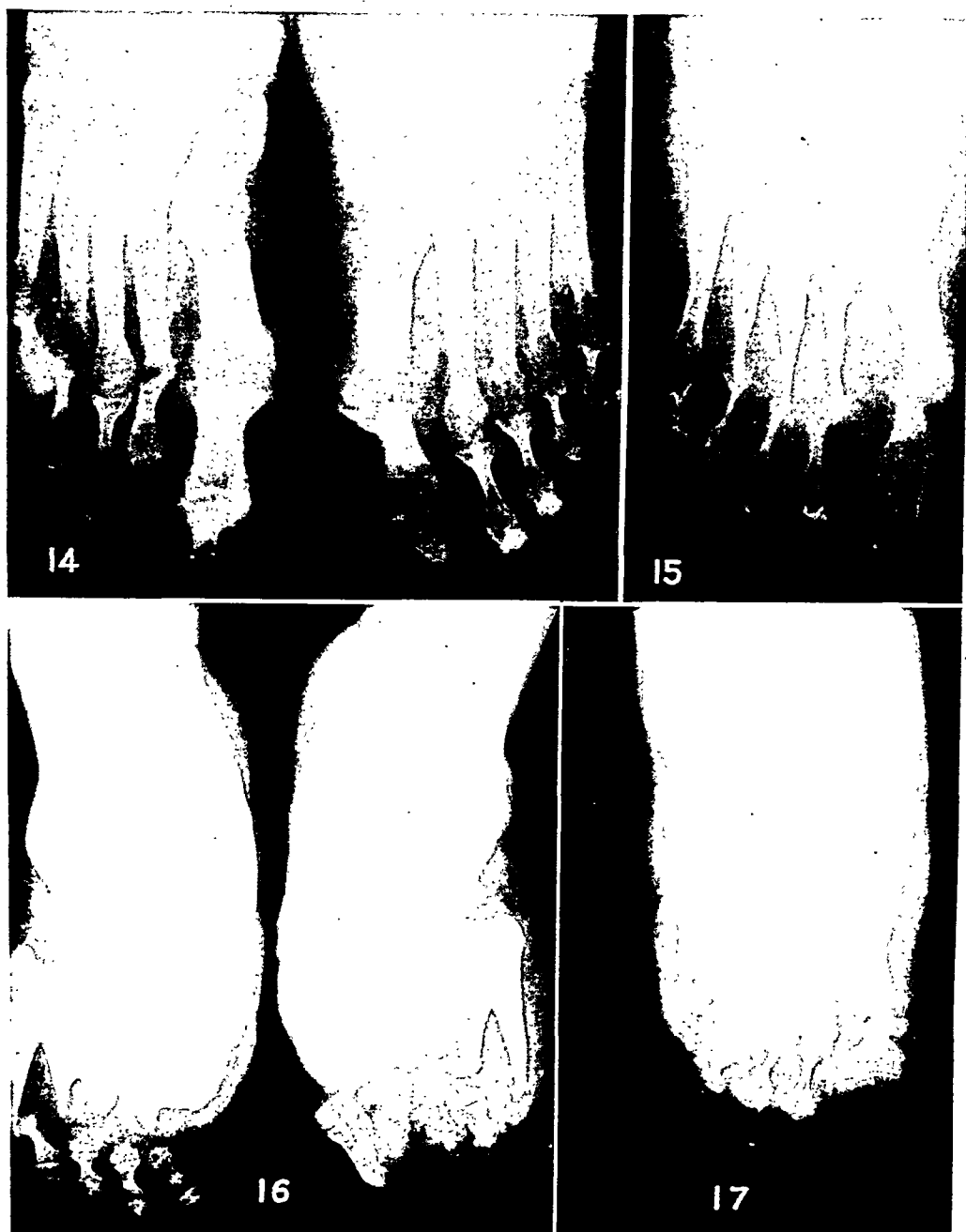


Fig. 14. Mixed leprosy of seventeen years' duration in colored male, Jamaican, 49 years of age. Right foot shows bony ankylosis of metatarsophalangeal joint of big toe, absorption of head of second metatarsal and base of second proximal phalanx, with subluxation and "concentric atrophy" of fourth proximal phalanx. Left foot shows "concentric atrophy," most marked in proximal phalanx of fourth toe. There is disorganizing arthropathy (Charcot joint) of the metatarsophalangeal articulation of the big toe.

Fig. 15. Neural leprosy of twenty-one years' duration in white female, American, 66 years of age. Advanced "concentric atrophy" of phalanges (some as fine as needles). Distal ends of most metatarsals show absorption of the "sucked stick-candy" type. Dislocation of metatarsophalangeal joint of big toe and old healed osteomyelitis of its shaft.

Fig. 16. Mixed leprosy of twenty-three years' duration in colored male, American, 42 years of age. Common mid-zone type of neurotrophic bone absorption with shortening of feet. Notice preservation of middle and distal phalanges in dislocated toes.

Fig. 17. Mixed leprosy of twenty years' duration in white female, American, 41 years of age. Spindle-shaped dactylitis of metatarsals. Different stages of neurotrophic bone absorption of toes.



Fig. 18. Neural leprosy of six years' duration in white male, American, 45 years of age. Note dislocated overriding toes and melting away of metatarsals into distal points.

the destructive activity of secondary pyogenic invaders entering through leprosy ulcerations of the nasal mucosa.

#### ARTERIOGRAMS

In order to confirm or disprove the possible relationship between the vascular supply of the hands and feet and bone destruction in leprosy, we have attempted to study the circulation of the extremities in our cases. X-rays of the hands and feet were taken during life and after death, in all types of the disease, following the injection of radiopaque solutions into the large arteries of the limbs. During life such arteriograms were made following the injection of thorotrast into the femoral and brachial arteries. At necropsy it was found that the best results were obtained through the arterial injection of lipiodol or other iodized oils.

From roentgenograms made after these injections of radiopaque material, very clear pictures of the arterial trees of the hands and feet were produced (Figs. 20 and 21). It is our impression from the study of these films that the arterial circulation of the extremities is not materially disturbed in neural leprosy. There seemed no causal relationship between the arterial supply of the hands and feet as demonstrated in arteriograms and the degree of neurotrophic bone absorption. In advanced



Fig. 19. Leprous endarteritis. Note leproma bulging into lumen of artery. Courtesy of Dr. C. H. Binford, U. S. Public Health Service.

lepromatous and mixed cases, on the other hand, localized arterial defects and decrease in size of arterial branches were found, which suggest the vascular leprosy lesions described by Fite and others.

#### CONCLUSIONS

1. In our experience bone changes in leprosy are for the most part confined to

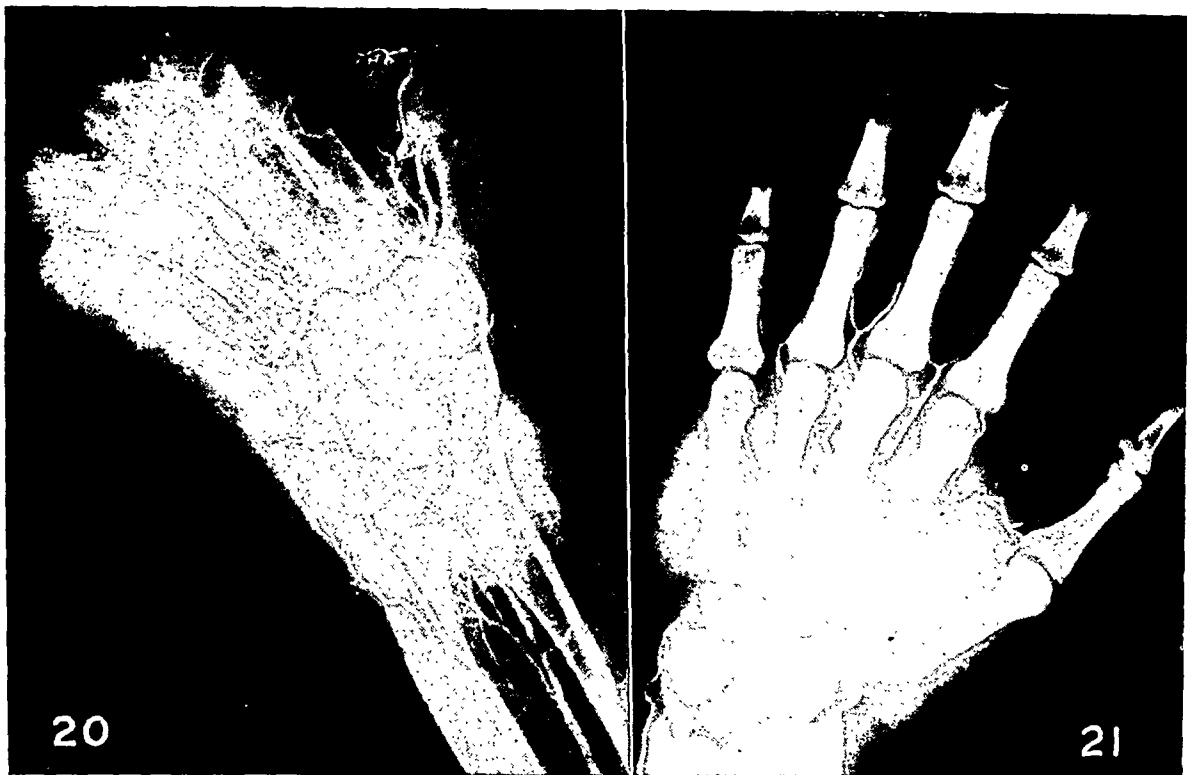


Fig. 20. Mixed type of leprosy of fifteen years' duration in white female, American, 58 years of age. Postmortem arteriogram of hand following injection of brachial artery with lipiodol.

Fig. 21. Lepromatous leprosy of ten years' duration in white male, Mexican, 37 years of age. Arteriogram made during life by injection of thorotrast into brachial artery. Note defects in some digital branches.

the neural type of infection. In this type they are not the result of direct local action by Hansen's bacilli within the bone but of the distant infection of the nerve trunks and are neurotrophic in nature.

2. Roentgenographically demonstrable bone changes in leprosy are not pathognomonic of this disease, except in advanced stages, but are similar to those of other neurotrophic nerve diseases, whether of central or peripheral origin.

3. The differential diagnosis of leprosy bone changes must not be based entirely upon the x-ray findings but must rely upon the other clinical and neurologic manifestations of leprosy, which are not present in simulating diseases.

4. An explanation is advanced for the difference in points of origin of the bone absorption in the hands and in the feet in neural leprosy.

5. The observation is made that in the upper extremities there is frequently either a preponderance of bone absorption with

almost complete exclusion of soft tissue involvement or, conversely, extreme muscular atrophy and contractures with little or no bone absorption.

6. A theory is advanced in explanation of this phenomenon, which has not heretofore been completely reported in the literature.

7. Arteriographic studies are interesting but have not thus far been helpful in observation of bone changes in leprosy.

8. Bone lesions in lepromatous leprosy are rare, consisting mostly of cyst formation, osteomyelitis, necrosis, periostitis, and enlargement of nutrient canals.

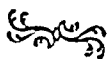
9. These changes are due to primary involvement of the bone marrow or periosteum by Hansen bacilli or to a vascular leprosy of the supplying arteries.

#### REFERENCES

- CHAMBERLAIN, W. E., WAYSON, N. E., AND GARLAND, L. H.: The Bone and Joint Changes of Leprosy: A Roentgenologic Study. *Radiology* 17: 930-939, November 1931.

## BONE CHANGES IN LEPROSY

- DYER, I., AND HOPKINS, R.: The Diagnosis of Leprosy. *Leprosy*. *Leprosy* 12: 45, 1911.
- FITE, G. L.: The Vascular Lesions of Leprosy. *Internat. J. Leprosy* 9: 193-202, April-June 1941.
- GASS, H. H., AND RISUM, D. P.: Examination of the Bone Marrow for *M. leprae*. *Leprosy Rev.* 5: 144, July 1934.
- HONKIJ, J. A.: Bone Changes in Leprosy. *Am. J. Roentgenol.* 4: 491-511, 1917.
- HOPKINS, R.: Bone Changes in Leprosy. *Radiology* 11: 470-473, December 1928.
- LEMANN, I. I., LILES, R. T., AND JOHANSEN, F. A.: Blood Serum Calcium in Leprosy. *Am. J. Trop. Med.* 7: 61-70, January 1927.
- MURDOCK, J. R., AND HUTTER, H. J.: Leprosy: A Roentgenological Survey. *Am. J. Roentgenol.* 28: 598-621, November 1932.
- WOOLEY, J. G. (with technical assistance of Hilary Ross): Phosphorus, Total Calcium, and Diffusible Calcium Content of the Blood Sera of Lepers and their Relation to Bone Changes. *U. S. Public Health Rep.* 46: 611-658, March 20, 1931.



# Absorptive Bone Changes in Leprosy<sup>1</sup>

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WITH FEW exceptions, the disease leprosy respects no human tissue. The skin may be involved by lesions of various types which can assume the characteris-

larly susceptible to attack by the bacillus of leprosy, often with resultant local destruction of the nerve fibers and loss of function of the part. In some cases, oste-

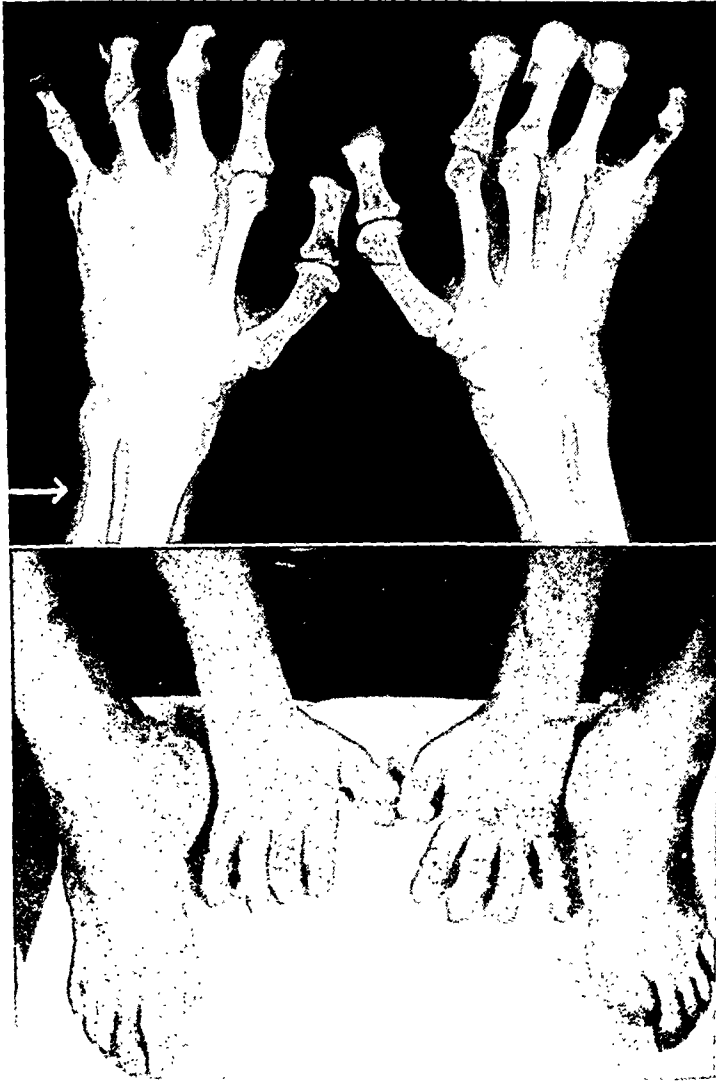


Fig. 1. Pressure erosion due to enlarged ulnar nerve.

tics of syphilis (1), tuberculosis (2), Besnier-Boeck sarcoid (3), and Raynaud's disease (4). Nerve structures are particu-

larly susceptible to attack by the bacillus of leprosy, often with resultant local destruction of the nerve fibers and loss of function of the part. In some cases, oste-

<sup>1</sup> Accepted for publication in May 1943.

the diseased vessel wall and alteration of the blood flow through the vessel. Tajiri (7) reported finding small leprous foci in the lungs. The bone may be the seat of local leprosy involving the periosteum (8) or the nutrient artery and nerve (9).

bone absorption which occurs in the small bones of the hands and feet in lepers.

Absorptive bone changes occur in the phalanges of the hands and in the metatarsal bones of the feet in leprosy. Such changes were described by Murdock and



Fig. 2. Osteoarthritis with resultant dislocation due to direct extension of contiguous soft-tissue leprosy.

The periosteum and cortex may be completely destroyed by pressure (Fig. 1), direct extension of contiguous soft tissue leprosy (Fig. 2), or by local disease of the nutrient artery and nerve (Figs. 3 and 4). It is the purpose of this paper to present and discuss the phenomenon of complete

Hutter (9) as minute nicks, slices, frayings, collar buttoning, and grossly prominent nutrient foramina which are demonstrable by roentgen examination and are considered of diagnostic significance. The generalized bone absorption which follows results in a complete loss or lysis of bone



structure (Figs. 5 and 6) and is associated with loss of sensation and muscle power in the hands and the feet due to sensory and motor nerve lesions. Neurocirculatory changes take place so that ulceration occurs at the points where usage causes pressure. While osteomyelitis, osteitis, and

absorption of the phalanges of the hands always occurs before the involvement of the metacarpal bones, beginning at the distal end of the distal phalanx. It is felt that this is due to the fact that in the feet it is the heads of the metatarsal bones and in the hands the tips of the carpal pha-

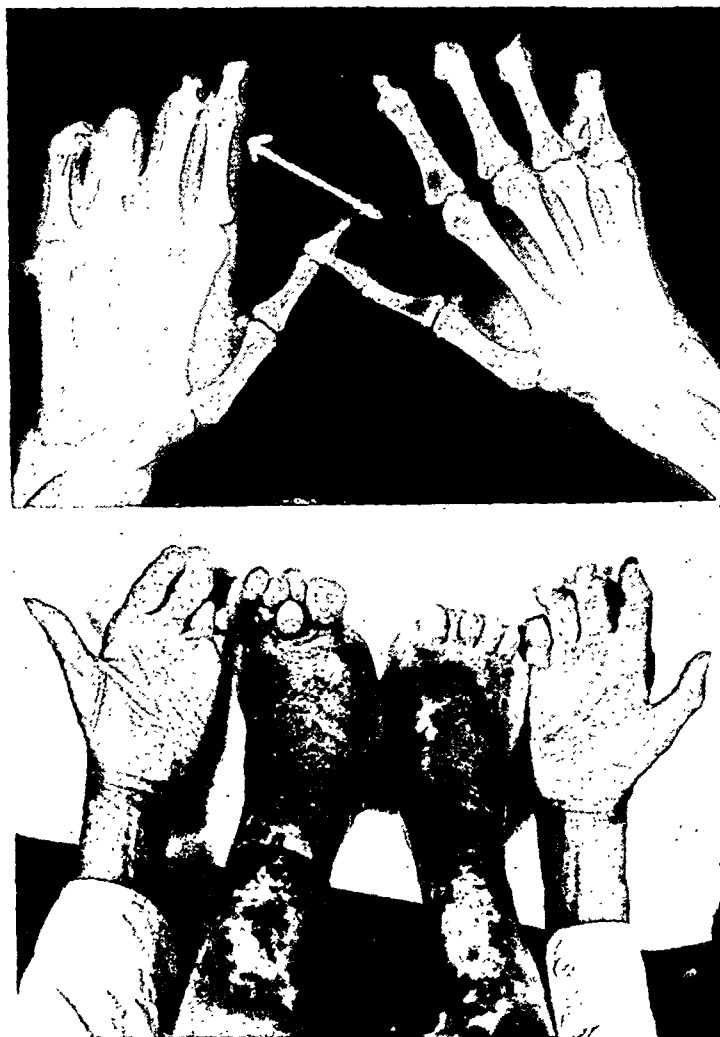


Fig. 3. Enlarged nutrient foramina.

arthritis may occur, they are merely co-existent and are not characteristic of leprosy.

Our study of roentgenograms of the hands and feet of lepers demonstrates a point not hitherto mentioned in the literature. The phalanges in the feet are often preserved intact even when there is marked destruction of the metatarsal and tarsal bones (Figs. 5 and 6). In contrast, the

phalanges that are subject to the maximum trauma and pressure in ordinary function and use.

Several factors account for the phenomenon of complete bone absorption: altered circulation, anesthesia, and pressure. Roentgenograms of the extremities of lepers clearly show generalized increased density in the areas where bone absorption has not been completed. Normally, when

the circulation to bone is decreased it undergoes consolidation, with increased density and osteosclerosis (10). Our physical examination showed a very strong pulsation in the large arteries of the wrists and ankles, which indicated to us that the general circulation was good or even better than

sufficient to account for the complete lysis of bone structure.

Mitsuda and Ogawa (12) found ascending degeneration of the tracts of Goll and Burdach of the posterior spinal column due to a leprotic peripheral neuritis in 68 per cent of neural and 50 per cent of cu-



Fig. 4. Enlarged nutrient foramina.

normal. Leitner (11) injected the arterial bed in amputated extremities of lepers and found that the arterial system was present in its entirety. We have roentgen proof of the local involvement of the nutrient artery and nerve in the early enlargement of the nutrient foramina (Fig. 3) and believe that the decrease in circulation is local with each individual bone. Alteration in the circulation alone, however, is not suffi-

cient to account for the complete lysis of bone structure. The leprotic degeneration of the peripheral motor and sensory nerve trunks and the degeneration of the tracts in the spinal cord are the pathological basis for the anesthetics of leprosy and the neurocirculatory disturbances discussed by Vishnevsky (13), who demonstrated considerable improvement in local leprosy lesions in the feet after novocain nerve block. This nerve block

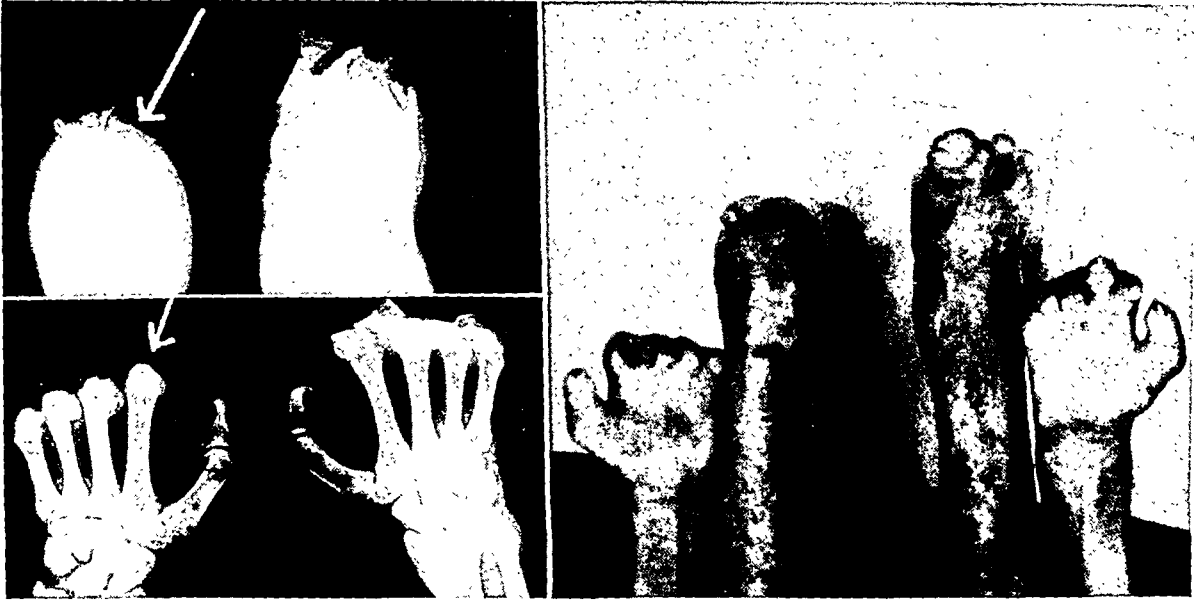


Fig. 5. Complete destruction of metatarsal and tarsal bones of left foot, with intact phalanges. Absorption of phalanges in hand, while metacarpals remain intact.

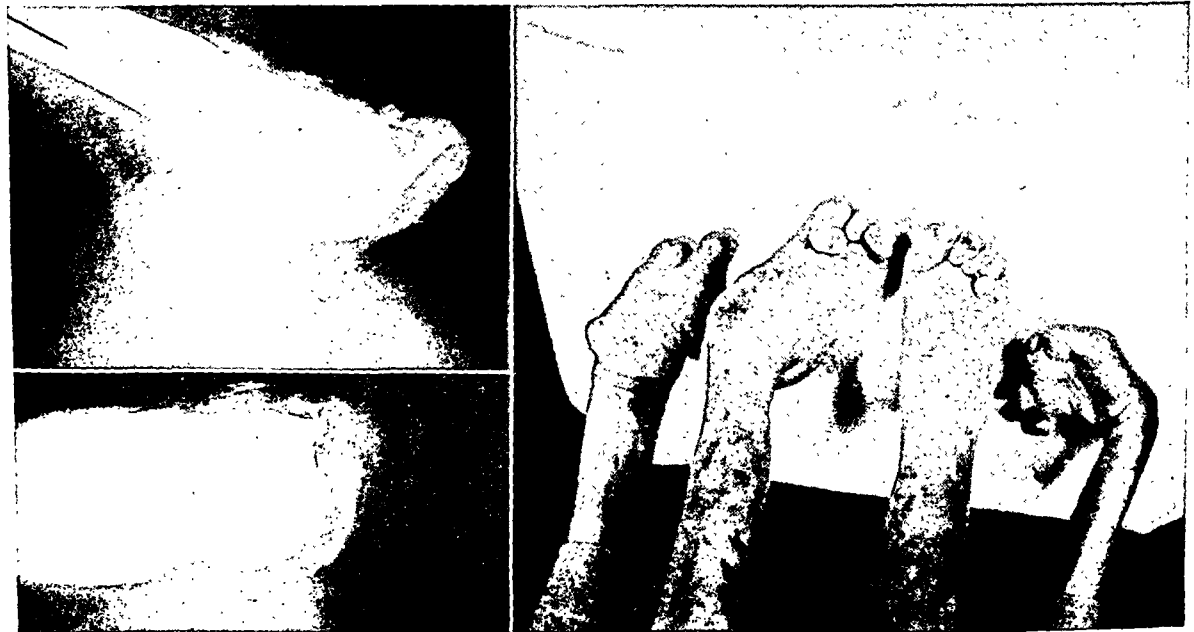


Fig. 6. Severe contracture deformities and generalized lysis of bone structure with persistence of phalanges of feet.

was applied only to the peroneal nerve at the ankle, but it upset the neurocirculatory balance sufficiently to cause long standing ulcers on the feet to heal and remain healed.

Pressure, the third factor in bone absorption, does not cause pain because of anesthesia. Although the bone absorption must proceed through the circulation,

the active force of pressure is necessary to complete the process. Figure 1 shows the phenomenon of bone lysis taking place at the lower end of the ulna at the site of a leproma of the ulnar nerve. Pressure accounts for the absorption of the bone, and the anesthesia of the wrist and hand permits the pressure to continue without pain.

The pressure necessary for the complete concentric absorption of the small bones comes from two sources. The first of these is the local leprosy lesions in the soft tissues of the hands and the feet, which produce constant pressure and cause the nicks, grooves, slices, and frayings of Murdock and Hutter. The second source of pressure is the trauma of use. The loss of muscle power, which is produced by the degeneration of the motor fibers in the nerve trunks, results in a muscular inequality in the intrinsic muscles of the feet. The normal arches of the foot are destroyed and deforming contractures result. The pressure caused by function is thereby increased, and the period of use prolonged because of the anesthesia, which has removed the limiting factor of pain. The pressure ulcers which follow are known as the neurotrophic ulcers of leprosy. When these occur, they cause additional pressure of local inflammation.

#### CONCLUSIONS

Fifteen patients were selected from a group of 120 with leprosy and studied in an effort to explain the phenomenon of complete concentric bone absorption. We believe that all the factors necessary for bone absorption are present, disturbance of circulation, anesthesia, and pressure. These three factors working together, without any other lytic agent or force, are sufficient

to account for all the bony changes that occur in leprosy.

The authors wish to express their appreciation to Dr. E. Hurwitz, Superintendent of the Palo Seco Leprosarium.

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#### REFERENCES

1. STRONG, RICHARD P.: *Stitt's Diagnosis, Prevention, and Treatment of Tropical Diseases*. Philadelphia, Blakiston Co., 6th ed., 1942, p. 816.
2. CECIL, RUSSELL L.: *A Textbook of Medicine*. Philadelphia, W. B. Saunders Co., p. 310; also ref. 1, p. 819.
3. REENSTHERNA, JOHN: Possible Role of Leprosy in the Etiology of the Besnier-Boeck Sarcoid and Schaumann's Syndrome. *Internat. J. Leprosy* 5: 433-436, October-December 1937.
4. KORNBLUM, KARL: Bone Changes in Raynaud's Disease as Revealed by Roentgen Ray. *Am. J. Roentgenol.* 21: 448-452, May 1929.
5. NOLASCO, J. O.: Calcification and Osteoid Changes in Nerve in Leprosy: Report of Case. *Internat. J. Leprosy* 4: 25-28, January-March 1936.
6. FITE, G. L.: Vascular Lesions of Leprosy. *Internat. J. Leprosy* 9: 193-202, April-June 1941.
7. TAJIRI, I.: Leprotic Changes in the Lung. *Internat. J. Leprosy* 3: 467-470, October-December 1935.
8. HURWITZ: Trophoneurotic Changes in Bones and Joints in Leprosy. *Arch. Int. Med.* 6: 147-169, 1910.
9. MURDOCK, J. R., AND HUTTER, H. J.: Leprosy: Roentgenological Survey. *Am. J. Roentgenol.* 28: 598-621, November 1932.
10. CAMPBELL, WILLIS C.: *Operative Orthopedics*. St. Louis, C. V. Mosby Co., 1939.
11. LEITNER, A. J.: Les osteo-arthropathies lépreuses du pied. *Internat. J. Leprosy* 6: 471-476, October-December, 1938.
12. MITSUDA, K., AND OGAWA, M.: A Study of One Hundred and Fifty Autopsies on Cases of Leprosy. *Internat. J. Leprosy* 5: 53-60, January-March 1937.
13. VISHNEVSKY, A. A., JR.: Novocain Blockade in the Treatment of Leprosy. *Internat. J. Leprosy* 6: 477-490, October-December 1938.



# Treatment of Retinoblastoma

## Radiation Therapy Supplementing Surgical Treatment<sup>1</sup>

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RETINOBLASTOMA is second in frequency of the malignant neoplasms of the eye, malignant melanoma being the most common. The tumor is also designated by pathologists as "glioma of the retina" and "neuro-epithelioma." Since it contains no glia cells, the older designation, "retinal glioma," has fallen into disrepute as an accurate descriptive term. It is still, however, the most commonly used name for this tumor.

Retinoblastoma arises for the most part from the ciliary portion or from the posterior segments of the retina. According to Wintersteiner (20), the origin is often multiple and chiefly from the posterior pole. The tumor grows into the eyeball, stripping the retina from the choroid or covering it with a mass of tissue which encircles the vitreous or penetrates it. It may invade the choroid to form a mass in that structure and may travel within the optic nerve to the base of the brain.

This tumor occurs in approximately 90 per cent of cases before the fourth year. In our small series 50 per cent were bilateral. Most authors report bilateral involvement in 20 to 25 per cent.

The treatment of retinoblastoma must be planned primarily, as in the case of any malignant tumor, to preserve life. This malignant tumor is different from many in that, while it may metastasize, its tendency to do so is not great; thorough local eradication may therefore effect a cure.

A second objective to be attained is

preservation of sight. We are faced with the alternative, in treating bilateral retinoblastoma, of recommending removal of both eyes as a life-saving procedure, or of attempting to destroy the tumor, at the same time conserving vision in one eye. This involves removal of one eye and irradiation of the other.

In a few cases it will be the purpose of therapy, whether surgical or by some radiation procedure, to relieve pain and make the last days of the victim as comfortable as possible, recognizing that neither sight nor life can be preserved.

The object to be attained will depend on the degree of involvement and progress of the disease. Of the three objectives, preservation of life must be considered of most importance. We must take the attitude in the treatment of malignant tumors that, generally speaking, no sacrifice is too great if there is a possibility that life can be maintained in a reasonable degree of comfort. In the discussion of the treatment of retinoblastoma found in the literature, the suggestion is made by several authors that, if it is necessary to remove both eyes, the ensuing life of blindness will be too unhappy to contemplate. They imply that the policy of letting nature take its course is more to be desired than bilateral enucleation. While there are cases on record of spontaneous cure of retinoblastoma without treatment (11), the possibility of this miracle is too remote to merit consideration. Anyone who has seen a neglected, untreated case go through the terminal days and weeks of suffering will certainly look with favor on any treatment,

<sup>1</sup> Presented before the Radiological Society of North America at the Twenty-eighth Annual Meeting, Chicago, Ill., Nov. 30-Dec. 4, 1942.

even though it results in a life of blindness, if it offers a small chance of avoiding such a death. It is doubtful if complete blindness, especially in one who perhaps cannot remember ever having been able to see, is a grave tragedy. It has been our observation that the properly trained blind person is usually a happy one. We maintain that it is not for the physician or parents to withhold from a child treatment that may be life-saving even though blindness results.

A large percentage of unilateral retinoblastomas will be cured by surgical removal of the eyeball with as long a section of the optic nerve as possible. A smaller number of patients with bilateral involvement may be saved by the same procedure. Reese (15) has shown in his study of a series of 119 cases of retinoblastoma a reason for routinely treating the optic nerve with radiation following enucleation. In this series 52 per cent showed malignant tissue invading the optic nerve posterior to the lamina cribrosa, and in 81 per cent of this group it was found that the optic nerve had not been severed distal to the extension of the tumor. "In other words," says Reese, "43 per cent of the 119 cases were doomed to failure before the patient left the operating room." Extension to the nerve occurred as frequently with a small as with a large growth. In the same series 10 per cent were shown to have broken through, resulting in extraocular extension. This occurred late, in the presence of a large growth. It seems logical to assume, in view of this study, that in some cases there will be a greater life expectancy if the orbit and optic nerve are given postoperative irradiation.

There is a feeling that if, on removal of the eyeball, no tumor is found in the nerve the prospect for cure is good. In at least one of our cases (Case 9), following surgical removal of the eyeball and a report of a normal nerve, recurrence developed in the nerve, projecting into the orbit. The rather large number of cases of massive recurrence in the orbit following enucleation also demonstrates the fallacy of de-

pending on surgery alone. We depend on postoperative irradiation in the treatment of carcinoma of the breast to improve our percentage of cured cases. It seems as logical to irradiate retinoblastoma postoperatively even though the pathologist finds no tumor in the nerve removed.

Some authors report a relatively high cure rate by surgical procedure alone. The following results have been recorded:

Hirschberg (6), 75 cases, 5 per cent cured  
Wintersteiner (20), 497 cases, 13 per cent cured (two-year cures)

Leber (10), 28 cases, 57 per cent cured

Adam (1), 46 cases, 57 per cent cured

Army Medical Museum (2), 95 cases, 14 per cent cured (five-year cures)

Whether radiation can add to the life expectancy remains to be seen. In our short period of observation we feel that it will.

Bilateral involvement constitutes a much more serious problem than retinoblastoma in a single eye. Our method of interstitial irradiation of the remaining eye is not a satisfactory solution of the problem of maintaining vision and, at the same time, preserving life. The method was instituted without precedent and has been discontinued in favor of a more logical procedure of external irradiation with x-rays as described by Martin and Reese (11 and 12).

Massive recurrent retinoblastoma or retinoblastoma that has metastasized to bones and to regional nodes is treated with no thought of cure. Our mission in a case of this type is to relieve pain and make the patient as comfortable as possible. One has the opportunity of demonstrating in a case of massive recurrence that, even though this tumor is not classified as radio-sensitive, it has a degree of sensitivity. We are therefore justified in the assumption that retinoblastoma, wherever found, if not surgically removable, should be given the benefit of irradiation.

#### HISTORICAL

Reports of treatment of retinoblastoma by radiation were published prior to 1920

by Hilgartner (5), Axenfeld (3), Kusama (9), Janeway (7), and Knapp (8). Several of these cases were not followed for a sufficiently long period of time to justify the value of the procedure. Schoenberg (16), however, reported a case in which, after enucleation of one eye, the other eye was treated with radium. At the end of three and one-fourth years the child was still alive with a cataract. Later the case was reported (17) as a ten-year cure with successful removal of the cataract. In discussing his case Schoenberg suggests the possibility of a spontaneous cure because of the small amount of radiation used. He agrees with Axenfeld (3), who very logically says: "Somewhere midway between the complete resistance to radiation and a tendency to spontaneous cure of the tumor there must be a group of retinogliomas that will respond more or less readily to x-ray and radium treatment."

Verhoeff (19) reported a case followed for three years, in which, with x-ray treatment, the tumor in the second eye was made to regress, with maintenance of good vision.

The first report of interstitial irradiation of the remaining eye is that by Moore, Stallard, and Milner (13). Removable radon implants averaging about 3.5 mc. with 0.5 mm. platinum filtration were used. Five patients were followed for twenty-two months or less. Definite regressive changes were seen in the tumor, but the time interval between the application of the treatment and the report of the cases was not sufficient to permit an opinion as to possible cure or preservation of sight. Stallard (18) later described in detail the surgical approach and technical method of applying a radon seed to the tumor.

Borley (4) reported the unsuccessful treatment of a retinoblastoma in the remaining eye with radium seeds enclosed in a stent of wax, so molded that it would closely fit the scleral curve. This was slipped into position after an incision was made through the conjunctiva and Ten-

on's capsule and after a tenotomy of the lateral rectus muscle was carried out.

Martin and Reese (11), in 1936, presented for the first time a scientific method of irradiation based on the biological principle developed by Coutard in the treatment of pharyngeal carcinoma. At the time of their report they had treated or were treating 6 cases of bilateral retinoblastoma, none of which had been followed for as long as three years. They were sufficiently satisfied with the regression of the tumor in the remaining eye, however, to advocate strongly the technic of divided doses of x-ray therapy, applied for a long period through multiple small portals.

A subsequent report in 1941 (12) on these and an additional 4 cases showed 8 of the patients living, 5 with vision. Two had had vision for six and seven years, respectively. Martin and Reese also report a series of 6 cases in which tumor was found in the portion of the nerve removed at enucleation. Five patients are living and well following irradiation. Nine patients with recurrent tumor in the orbit are all dead. The fact is emphasized that immediate irradiation of the nerve and orbit of the enucleated eye offers a good chance for cure even though the optic nerve is involved, while if there is recurrence in the orbit before irradiation is started the prognosis is extremely poor or hopeless.

#### DIAGNOSIS

Usually an accurate diagnosis of retinoblastoma can be made by the ophthalmologist. It is important, of course, that his clinical impression shall be accurate, since this is one tumor that does not lend itself to biopsy with the possibility of subsequent removal following pathological verification of the diagnosis.

A study made by Pfeiffer (14) reveals the fact that 75 per cent of retinoblastomas contain calcification. This appears as a characteristic, mottled, irregular pattern. Roentgen examination should be done in all doubtful cases in an attempt to demonstrate this calcification.

#### AUTHOR'S METHOD OF IRRADIATION

Our radiation therapy has been used (1) to prevent recurrence following enucleation of an eye because of retinoblastoma and (2) to preserve vision in the remaining, least involved eye when the tumor was bilateral.

In treating the optic nerve stump following enucleation we found 10-mg. monel metal needles ideal in size for insertion. We recognize the advantage of heavily filtered radium in the treatment of many malignant processes. In this situation, however, irradiation is limited to the few millimeters adjacent to the optic nerve stump, and we felt that a caustic dose would be more efficient than a more penetrating ray produced by heavier filtration. We also felt that, if the needles could be left in place for a relatively short period of time, danger of infection would be less than if needles of low radium content and high filtration remained in place for a long period. The needles we use are filtered with monel metal, having a wall thickness of 0.3 mm. The total length is 19 mm. and the radioactive length is 12 mm. The insertion of gold-filtered implants as a prophylactic procedure would have been as logical, possibly, as the procedure adopted by us but, since the implants were not readily available locally, this type of radium therapy was not considered.

Our method in most cases was to implant from four to six monel needles, usually of 10-mg. size, adjacent to the nerve stump. This was done immediately following enucleation. The dose varied between 400 and 1,000 milligram hours. If the tumor had broken through the sclera or if it was a recurrent tumor following enucleation, a radium capsule having a wall thickness of 1 mm. gold was packed into the orbit following removal of the tumor. A dose as high as 1,350 milligram hours has been given. It is possible that in lesions of this type deep x-ray therapy to the orbit would be just as satisfactory in its ultimate result as is radium used as described.

In our earlier cases, when the other eye also contained tumor, we used the same

type of radium needles. A ring of four or five 10-mg. needles was implanted between the sclera and Tenon's capsule about the periphery of the orbit, getting as great a concentration of radiation as possible close to the tumor. The needles were left in place for a dose varying from 350 to 610 milligram hours.

We have discontinued treatment of the remaining eye with radium needles because of the damage produced in the normal elements of the eyeball by the caustic dose. X-ray therapy with 200 kv.p. and heavy filtration brings about regression of the tumor with fewer complications. The beam is directed through three small ports cross-firing the eyeball.

#### COMPLICATIONS

Meningitis is a possible complication following any intraorbital instrumentation or manipulation. Our needles were inserted into the tissue of the posterior orbit under the same sterile precautions and, in fact, as part of the same operative procedure as the enucleation. We have had no case of meningitis. Martin and Reese (12) report one death from meningitis following insertion of radon seeds. In this case they were dealing with a recurrence, with a large mass filling the orbit. The implants were inserted following the removal of the mass. It seems to us that a recurrent tumor will be more likely to become infected than a primary one. We are recommending the use of radium inserted into and adjacent to the optic nerve stump only after removal of a primary growth and not after removal of a recurrence.

Martin and Reese (12) have thoroughly discussed the complications that occur following x-ray therapy. These can be listed as follows: keratinization of the conjunctiva and corneal epithelium; glaucoma; cataract; atrophy of the globe. Any of these complications may occur with our method of radium therapy. Atrophy of the globe is the most common complication when radium is inserted about the periphery of the remaining eyeball. While we are not advocating our



TABLE I: SUMMARY OF DATA ON TWENTY CASES OF RETINOBLASTOMA

Case, Age, Sex	Degree of Involvement	Evidence of Nerve Involvement	Treatment	Living or Dead	Duration of Life Since Treatment	Vision	Primary or Recurrent
1. 13 yr. M.	Single	Yes	X-ray therapy following enucleation of left eye	Living	21½ yr.	Good in unin- volved eye	Primary
2. 4 yr. M.	Single	No	Single small dose of x-ray therapy follow- ing enucleation	Dead 2 months later			Primary
3. 5 yr. M.	Single	No	Enucleation of left eye; no radiation	Living	17½ yr.	Good in unin- volved eye	Primary
4. 15 mo. F.	Both	No	Enucleation of left eye. Radium pack and x-ray to right eye	Living	16⅔ yr.	3/60 in right eye	Primary
5. 2 yr. M.	Single	No	Surgical removal of left eye	Not followed			Primary
6. 2 yr. F.	Single	Yes	Surgical removal; no radiation	Dead 3 months later			Primary
7. 2 yr. M.	Both	Unknown	None	Not followed			Primary
8. 11 mo. F.	Both	No	Enucleation; first left, later right. Inter- stitial radium	Dead 3 years later			Primary
9. 2 yr. F.	Single	None seen by pathologist but recur- rence later	Enucleation and interstitial radium about nerve head	Living	9 yr.	Good in unin- volved eye	Primary— later re- current
10. 2 yr. F.	Single	No	Removal of recurrent mass and interstitial radium	Dead 6 months later			Recurrent
11. 14 mo. M.	Both	Unknown	Refused by parents	Not followed			Primary
12. 4 yr. F.	Single	Yes	Removal of recurrent mass and interstitial radium	Dead 14 months later			Recurrent
13. 15 mo. M.	Both	Yes	Enucleation of left eye. Radium inter- stitially to stump on left and to right eye	Living	7½ yr.	Light perception	Primary
14. 18 mo. M.	Both	Yes	Interstitial radium and bilateral enuclea- tion	Dead a year and a half later			Primary
15. 9 mo. F.	Both	No	Enucleation of left eye. Interstitial ra- dium. Later enucleation of right eye	Living	7 yr.	None. Both eyes removed	Primary
16. 6 wk. M.	Single	No	Enucleation; x-ray therapy	Living	4 yr.	Good in unin- volved eye	Primary
17. 3 mo. M.	Both	No	Enucleation of left eye. X-ray therapy to right eye	Dead 3½ years later			Primary
18. 9 mo. M.	Both	No	Enucleation of left eye. X-ray therapy to right eye	Dead 2 years later of pneumonia			Primary
19. 3½ yr. M.	Both	No	Enucleation of right eye. X-ray therapy to left eye	Living	2½ yr.	20/50 in left eye	Primary
20. 4 yr. M.	Single	Yes	Removal of recurrent tumor and x-ray therapy	Dead 5 months later			Recurrent

method as a means of conserving sight in the remaining eye, we point to the one case in which light perception has been present for a period of seven years following this method of treatment, without atrophy of the eyeball (Case 13).

Our method of treating the remaining eyeball was used before the technic and results of x-ray therapy were described by Martin and Reese. We have since adopted a modification of their procedure and are using it in preference to radium insertion. In the treatment of the optic nerve stump, however, we advocate implantation of radium needles or radon seeds about the nerve head as a more satisfactory method than roentgen therapy. The insertion is done while the child is quiet under the influence of an anesthetic. Movement of the patient during x-ray therapy may render satisfactory accurate localization of the ray difficult. The treatment with radium may be accomplished in a few hours as compared to a long time interval if x-ray therapy is used. A caustic dose may be applied to the few millimeters of the nerve that may be involved. If involvement has spread farther than a few millimeters, it is doubtful if any type of radiation will be of great value.

### RESULTS

During the twenty-one-year interval between April 1921 and August 1942 our records show that 20 cases of retinoblastoma have been seen in The University of Kansas Hospitals. Data on these cases are tabulated as follows:

TOTAL CASES.....	20
Primary.....	17
Recurrent (following removal elsewhere).....	3
BILATERAL RETINOBLASTOMA.....	10
Dead.....	4
Living.....	4
All treated with surgery and radiation.	
Life duration since treatment:	
Case 4: 16 1/2 years	
Case 13: 7 years (in this case tumor was seen in the nerve of the enucleated eye)	
Case 15: 7 years	
Case 19: 2 1/2 years	
Not followed (considered hopeless, not treated).....	2

UNILATERAL RETINOBLASTOMA.....	10
Treated by surgery alone.....	3
Dead.....	1
Living.....	1
Case 3: 17 years	
Not followed.....	1
Treated by surgery and radiation.....	7
Dead.....	4
Includes 3 recurrences after operation elsewhere	
Living.....	3
In 2 of these tumor was demonstrated in the optic nerve at operation	
Case 1: 21 years	
Case 9: 9 years	
In one no tumor was seen in the optic nerve at operation	
Case 16: 4 years	
RECURRENT RETINOBLASTOMA.....	4
Dead.....	3
Living.....	1
Case 9: This case was seen by us as a primary tumor. The eye was enucleated and radium was implanted about the optic nerve stump. Recurrence followed and was again treated with radium implants about the stump of the optic nerve. This is now a 9-year cure.	
PATIENTS WITH BILATERAL RETINOBLASTOMA WITH SIGHT IN ONE EYE.....	3
Treated with x-ray and radium surface application.....	1
Case 4: 16 1/2 years	
Treated with x-ray only.....	1
Case 19: 2 1/2 years	
Treated with interstitial radium.....	1
Case 13: 7 years	

### CASE HISTORIES

CASE 1 (Hospital No. 10622): G. K., white male, age 13, was seen in Doctor Curran's office Oct. 22, 1920, complaining of inability to see with the left eye. There had been pain in the eye all summer. This eye felt harder than the right, but the change was not marked. A cataract was at first suspected; later a definite diagnosis of glioma was made, and in April 1921 the eye was enucleated. The pathological report was glioma of the retina with extension to the optic nerve.

Following operation, x-ray therapy was given to the orbit, in the office of Doctors McDermott and Virden of Kansas City, Mo. Between April 30, 1921, and Nov. 12, 1921, the patient received seven treatments anterior to and seven lateral to the orbit. Factors were recorded as follows for each treatment: 5 ma., 8-in. spark gap, 5 mm. Al filter, distance 12 in., time 8 minutes.

This boy, even though there was tumor in the optic nerve, is living twenty-one years following the diagnosis of retinoblastoma. He was seen in May 1942, by Doctor Curran.

CASE 2 (Hospital No. 11487): J. F. R., white male, age 4, was admitted Nov. 18, 1921. On Nov. 10 his mother noticed a peculiar light reflex in the left eye and discovered that the patient could not see with this eye. The results of physical examination were reported as follows: "The child is blind in the left eye. The vitreous chamber is almost filled with tumor. Small round floating opacities are seen in the vitreous. The largest of these is 1 mm. in diameter. The right eye appears normal."

On Nov. 18, the left eye was enucleated. The pathological report was glioma of retina. A section through the optic nerve showed no tumor cells.

From Nov. 20 to Nov. 26, 1921, x-ray therapy was administered to the anterior left orbit, with the following factors: 4 ma., 8-in. spark gap, 4 mm. Al filter, distance 12 in., time 8 minutes.

The child died at home on Jan. 4, 1922. There was no recurrence in the orbit. Two weeks prior to death, when the patient was last seen, the liver was almost twice normal size. It was nodular in a manner characteristic of tumor metastasis.

CASE 3 (Hospital No. 16427): E. A., white male, age 5, was admitted June 21, 1925. Eight months earlier the mother noticed a white object inside of the left eyeball. The patient stated that he had some pain in the eye. A whitish reflex was seen on examination of the left eyeball. The right eye appeared normal. The clinical diagnosis was retinoblastoma and the left eye was enucleated, June 22, 1925. The pathological diagnosis was glioma of the retina.

The patient came in for observation on Aug. 27, 1942. He is attending school and appears to be in perfect health.

CASE 4 (Hospital No. 18208): A. K., white female, age 15 months, was admitted Jan. 7, 1926. Her mother had noticed a spot on the left pupil when the baby was six weeks old. The spot spread gradually over the eye. A clinical diagnosis of retinoblastoma was made by Doctor Curran.

On March 12, 1926, the child was admitted to the hospital for enucleation of the left eye. A diagnosis of retinoblastoma in the right eye, also, was made at this time.

The larger part of the tumor in the left eye was in the posterior portion of the eyeball. A considerable amount of gritty, sand-like material was found here. The histological report was glioma of the retina.

The child was given one x-ray treatment (May 25, 1926) and several radium treatments in the office of Doctors McDermott and Virden of Kansas City, Mo. (Unfortunately the record of treatment has been lost, but Doctor Virden recalls that a small radium pack at a distance of 1/2 in. was applied several times.)

Nov. 26, 1926: The mother thinks that the child sees better. Examination of the fundus of the right eye shows less tumor.

Sept. 1, 1931: The tumor has cleared up above

the disk. White areas are still seen. Remains of old hemorrhage are seen adjacent to the macula.

Aug. 2, 1933: Vision in the right eye is 15/200 without glasses.

Sept. 17, 1942: A letter from the father says the child is in a school for the blind. Her vision without glasses is 3/60.

CASE 5 (Hospital No. 21398): E. L. S., white male, age 2, was admitted Jan. 27, 1927. Four months earlier it was noticed that the child's vision in the left eye was poor and that the pupil of his left eye had a white reflex. At the time of admission there was no vision in the left eye, and the pupil had a grayish, glassy appearance. The eye was enucleated Jan. 28, 1927, and the pathological report was glioma of the retina. We were unable to follow this case.

CASE 6 (Hospital No. 28067): B. S., white female, age 2, was admitted June 28, 1929. Two weeks earlier the child was seen to have a swollen eyeball. Examination showed the right eye protruding from the socket and the lower conjunctiva everted, edematous, and inflamed. The child had pain.

The right eye was enucleated July 19, 1929. Tumor could be felt entering the cranial cavity through the optic foramen, on examination following enucleation. The pathologic diagnosis was retinoblastoma showing invasion of the optic nerve and extension into the tissue outside the eyeball.

The child died at home, Oct. 1, 1929.

CASE 7 (Hospital No. 39663): R. B., white male, age 2, was admitted May 9, 1932, and dismissed the same day. Gradually growing white masses had been noticed in both eyes for one year. The child had been blind for this period. The right eyeball was enlarged and nodular, filled with a yellow mass. There was a yellow mass, also, filling the posterior half of the left eye, with blood vessels extending over the mass. Hard cervical nodes were palpated on both sides. Because of the hopelessness of the condition, no treatment was advised. The case could not be followed.

CASE 8 (Hospital No. 44249): G. R., white female, age 11 months, was admitted April 28, 1933. As soon as the child was born the parents noticed something peculiar about the left eye. At eight months of age a doctor was consulted, and a diagnosis of congenital cataract was made. Two months prior to admission photophobia and a slight discharge developed in this eye.

The left eye was enucleated May 16, 1933. The pathological report was retinoglioma, showing necrosis and calcification.

From June 26 to June 28, 1933, a total dose of 1,000 r was delivered into the left orbit. The factors were as follows: 120 peak kv., 5 ma., 3 mm. Al filtration, distance 13 in.

On Dec. 27, 1934, the child was readmitted, with tumor in the right eye. Six 10-mg. monel metal needles were inserted about the periphery of the right eye, for a total dose of 360 mg. hours.

The patient was again readmitted April 10, 1935. Examination by Doctor Curran at that time showed a great deal of disintegration of the tumor. The subsequent history was as follows:

*May 6, 1935:* Following insertion of radium the eyelids became edematous. There has been photophobia. On examination the right eye shows a muddy anterior chamber and there are a few posterior adhesions. There is deep pericorneal injection.

*June 17, 1935:* The patient is listless; appetite is poor; she will not play.

*July 7, 1935:* The patient is feeling much better. She plays some and does not sleep so much. Her appetite is still poor.

*Oct. 9, 1935:* Examination shows the left periorbital tissue considerably depressed. There is a slight mucopurulent discharge from the right eye. Six 10-mg. monel metal needles were inserted about the periphery of the right eyeball, for a total dose of 250 mg. hours.

*Jan. 6, 1936:* During the last six weeks the right eyeball has been getting larger. Discharge is present and there is considerable pain. Examination shows an enlarged right eyeball; it is tender; there is a purulent discharge.

*Jan. 15, 1936:* Right eye removed. Pathologic diagnosis: Retinoblastoma with infiltration into the optic nerve, right eye.

*Jan. 22, 1936:* Five 10-mg. radium needles were inserted for eight hours about the nerve head on the right. A total dose of 400 mg. hours was given.

*Feb. 11, 1936:* Condition is critical.

*March 17, 1936:* Patient died at home.

**CASE 9 (Hospital No. 46174):** V. A. W., white female, age 2, was admitted Sept. 3, 1933. Ten months previously the parents noticed a gray spot in the right eye when light came in from the side. This had gradually enlarged. Two months before admission they noticed that the sight was gone from this eye. Examination showed a cat's eye reflex in the right eye and gray floating opaque material, clumped and nodular, in the vitreous humor.

The right eye was enucleated on Sept. 3, 1933. Five 5-mg. radium needles were imbedded about the optic nerve, for a total dose of 250 mg. hours. The pathological report was retinoblastoma of the right eye. "A section was taken through the optic nerve. No cells that were recognizable as tumor cells could be seen. However, in the loose tissue around the outside of the sclerotic coat, there are some rounded oval cells, of an atypical nature, which may be neoplastic in origin."

The child was readmitted for observation Oct. 9, 1933. The eye had healed well but there still remained a small opening in the region of the optic foramen.

*Jan. 29, 1934:* Patient admitted for observation. There is recurrence of tumor in the nerve head.

Five 10-mg. radium needles were inserted about the optic nerve head and left in place for fifteen hours. Total dose, 750 mg. hours.

*Feb. 5, 1934:* A letter from the mother of the patient states: "For the first four days Virginia took practically no nourishment. Seemed to be more or less in a stupor. She does not appear to be in a great deal of pain. She wants to be held or rocked most of the time and rests this way easily. It has been necessary to give her codein tablets at night in order for her to get any sleep."

*Nov. 7, 1934:* The patient was seen. She looks well; there is no recurrence.

*Sept. 1, 1935:* Letter from mother: "Virginia Ann seems to be in the best of health. She is quite active and plays with other children freely."

The patient was seen at intervals during 1936, 1937, and 1938. On the last examination, March 1, 1938, there was no evidence of recurrence.

*Aug. 10, 1942:* A letter from the mother informs us that the patient is in perfect health.

**CASE 10 (Hospital No. 51065):** B. J. W., white female, age 2, was admitted Aug. 22, 1934. Four months earlier the mother noticed that the left eye showed a cat's eye reflex. The eye began to enlarge. Three months prior to admission the eye was removed in another hospital. Five days before admission the tumor was seen to be growing, causing the lid to bulge.

The left lids were almost closed, yet bulged slightly from an apparent growth behind. This growth was cellular in appearance and grayish-white in color; blood vessels were seen running over the surface. On Aug. 24, by sharp dissection and cautery the tumor was removed. The pathological report was recurrent retinoglioma.

Following removal of the tumor, five 10-mg. monel needles were inserted into the tissue adjacent to the optic nerve, a total dose of 750 mg. hours being given. Twenty-five milligrams, in a capsule 1.5 cm. long with 1-mm. gold wall, was packed into the orbit. A total dose of 500 mg. hours was given.

Examination on Sept. 24, 1934, showed the patient to be very fretful, but otherwise normal. For a period of approximately one week following irradiation she was bright and felt well. Then she grew restless, had temperature as high as 100°, became drowsy, and complained of pain in the back of her head. She had no convulsions. It was felt that her condition was probably due to the radiation rather than tumor extension. Temperature ranged from normal to 101° during eight days in the hospital.

The patient was readmitted Jan. 11, 1935, and following this recuperated rapidly, was very active and felt good. Six weeks previously she had a cold and complained of pain in the muscles. There had been some difficulty in locomotion. Examination showed the liver down about two fingers breadth. The right eye was normal. There were some nodules in the lower portion of the left orbital cavity which might possibly be due to recurrence.

Death occurred at home, Feb. 23, 1935. Convulsions occurred prior to death and the child suffered considerably.

CASE 11 (Hospital No. 53531): K. Y., white male, age 14 months, was admitted Feb. 2, 1935. About two and one-half months earlier it was noticed that the left eyeball was more prominent than the right. This became gradually more pronounced, and two weeks before admission a physician informed the family that the child had a tumor in the left eye.

Physical examination showed a large glioma in the left eye. The retinal vessels were fairly normal. There was a glioma, also, in the right eye, pushing the posterior portion of the retina forward.

Surgical removal of the left eye and radiation therapy of the right eye were recommended, but refused by the parents. The child was dismissed on Feb. 2, 1935, without treatment. There is no follow-up record on this case.

CASE 12 (Hospital No. 53769): M. C. H., white female, age 4, was admitted Feb. 20, 1935. A small tumor had been discovered in the right eye seventeen months previously. This had increased gradually in size, and the eye was removed, Nov. 5, 1934, at another hospital. Recently the child had not felt well and the remaining tissue in the right orbit had increased in size. The pathological diagnosis at the other hospital was glioma of the retina with extension into the optic nerve.

Examination showed bulging of the lids of the right eye and replacement of the eyeball by a tumor.

The tumor in the right orbit was removed Feb. 22, 1935, with the endotherm. The pathological report was glioma of the orbit. Five 10-mg. monel needles were inserted adjacent to the optic foramen, for a dose of 800 mg. hours. Into the orbit a 25-mg. capsule was packed (filtration 1 mm. gold) at a distance of 1 cm. from the posterior wall, for a total dose of 1,350 mg. hours.

About Aug. 5, 1935, it was noticed that vision in the left eye was gone. As no evidence of tumor could be seen in the orbit, it was assumed that the loss of vision was due to extension to the optic nerve on this side.

The patient was readmitted Nov. 5, 1935. Three weeks earlier she had begun to vomit, had lost her appetite, and had a moderate cough. Examination showed moderate drainage from the right orbit. No evidence of tumor was seen in the left orbit. The patient was blind in that eye. X-ray examination showed spreading of the sutures, due to increased intracranial pressure.

The patient remained in the hospital until April 20, 1936. During most of this period she was unconscious. Temperature ranged as high as 105°. Death occurred in the hospital. No source of infection was seen to account for the child's condition. Unfortunately an autopsy could not be obtained. It is our opinion that meningeal irritation from tumor could account for the symptoms described, including the high temperature.

CASE 13 (Hospital No. 54792): F. C., white male, age 15 months, was admitted April 23, 1935.

Three months before this the mother had noticed a red reflection from the left eye at night when light was directed into the eye. Two weeks later the conjunctiva became inflamed. Physical examination revealed retinoblastoma in each eye. The left showed the greatest involvement.

On April 27, 1935, enucleation of the left eye was done, followed by radium insertion. The pathological report was: "neuroglioma of the retina showing some secondary inflammatory reaction. A portion of the optic nerve can be seen in which rather extensive tumor infiltration can be recognized." Six 10-mg. monel metal needles were inserted about the periphery of the right eyeball; dose 350 mg. hours. Nine 5-mg. monel metal needles were inserted adjacent to the optic nerve of the enucleated left eye; dose 810 mg. hours.

June 10, 1935: Examination shows that the tumor in the right eye has regressed

July 9, 1935: There is only slight discharge from the left optic foramen; a bandage is not necessary. The lids are swollen. The child sleeps much and plays but little. He has no fever.

Dec. 3, 1935: The health is normal. The child is gaining weight, sleeps well, and eats well.

Dec. 24, 1935: The patient was seen at this time. He has vision in the right eye.

Feb. 26, 1936: The mother feels that the sight in the right eye is normal.

March 20, 1936: The sight appears normal. Child is gaining weight.

June 27, 1936, and Dec. 16, 1936: The mother considers the sight in the right eye normal.

Sept. 1, 1937: The mother reports by letter that the vision is failing.

Dec. 2, 1937: The general health is good but vision is becoming progressively less.

Dec. 11, 1937: An ophthalmoscopic examination was attempted by Doctor Trueheart of Sterling, Kans. He was unable to see the fundus, due to a cloudy lens.

Nov. 14, 1938: The general health is good. The patient has been seen by Doctor Curran, who says he has a cataract.

Oct. 29, 1941: Removal of right cataract done by Doctor Curran.

June 12, 1942: The vision has not been much improved by the operation. The patient can see trees and other large objects.

Oct. 1, 1942: The child is in the Kansas School for the Blind. He can detect light. No further surgical treatment is recommended at this time.

CASE 14 (Hospital No. 56913): R. E. F., white male, age 18 months, was admitted Sept. 1, 1935. At four months of age it was noticed that the right pupil did not appear dark. Vision failed until total blindness occurred. Three weeks prior to admission the same change was noted in the left eye. Examination showed no response to light flashed in the right eye. There was light perception on the left. The right eye was larger than the left eye.

The right eye was removed on Sept. 6. The pathological report was: "retinoglioma showing extensive secondary inflammatory reaction. Tumor tissue does not directly invade the substance of the optic nerve but it is immediately around it." Six 10-mg. and one 5-mg. monel needles were inserted about the periphery of the left eyeball for a total dose of 390 mg. hours. Six 5-mg. needles were inserted into tissue adjacent to the nerve stump on the right, for a total dose of 710 mg. hours.

On Dec. 15, 1935, the child was readmitted and the left eye was enucleated because of ulceration and tumor formation. Under general anesthesia it was found that the cornea had ruptured and the iris had prolapsed. Pathological examination of this eye did not reveal evidence of tumor, which had been suspected clinically. Following operation three 10-mg. needles were inserted into tissue adjacent to the nerve stump of the right eyeball, for 150 mg. hours. Five 10-mg. needles were inserted into tissue adjacent to the nerve stump of the left eyeball for 250 mg. hours.

Nov. 9, 1936: The patient was seen by Earl H. Gray, M.D., Woodland, Calif., who reports: "The little lad is apparently in good health but has developed a mass in the left temporal area that could be metastatic."

March 22, 1937: Letter from Doctor Gray: "Richard F— died on about March 7, 1937. He had extensive metastasis to the right supraclavicular chain and clinically appeared to have extensive intracranial metastasis." Examination of the masses in the neck, postmortem, by James B. McNaught, M.D., showed "retinoblastoma, metastatic."

CASE 15 (Hospital No. 57237): J. M. H., white female, age 9 months, was admitted Sept. 22, 1935. Her mother had first noticed that the left eye had a brownish color about two months earlier. Under a general anesthetic both eyes were found to contain tumor. The left eye was enucleated and radium was inserted about the stump of the nerve: three 10-mg. needles for a dose of 435 mg. hours. X-ray examination of the left eye, before and after enucleation, showed calcification in the posterior chamber. The pathological report was "glioma of the eye showing secondary calcification."

Oct. 3, 1935: The child was readmitted. "There is no vision in the right eye. There is profuse drainage from the left orbit." Six 10-mg. monel metal needles were inserted about the periphery of the right orbit, for a total dose of 210 mg. hours.

Oct. 10, 1935: Readmission. Doctor Curran reported as follows: "There has been regression of the tumor in the right eye. A gliomatous mass is still present in the upper nasal quadrant and in the region of the macula."

Nov. 6, 1935: Radium needles were again inserted about the periphery of the right eye—five 10-mg. monel needles, for a total dose of 150 mg. hours.

Dec. 11, 1935: Readmission. Examination showed the eye to be quiet, with regression of tumor. No therapy.

Feb. 4, 1936: Readmission. Regression of tumor was seen.

Feb. 7, 1936: Six 10-mg. radium needles were inserted about the periphery of the right eyeball, for a total dose of 210 mg. hours.

June 8, 1936: A letter from the parents says: "She has only partially opened her eye, which is covered with a thick film. This seems to be getting thicker. Until recently she could see a little, now she apparently has no vision. The eye does not appear to be swollen or irritable."

June 21, 1936: Readmission. Since leaving the hospital five months ago, the child has gained weight and has been apparently quite healthy. There is very little orbital drainage on the left side. The right eyeball is shrunken. It was examined under anesthesia and it was decided that the eye should be removed.

July 12, 1936: Under general anesthesia the remains of the right eye were removed. The pathological report was "chronic inflammatory and scar tissue containing some clumps of neoplastic cells in the blood vessels." Three 10-mg. monel needles were inserted (July 15) about the nerve head on the right for a total dose of 450 mg. hours.

Feb. 12, 1937: A local physician reported only slight drainage from the right eye.

May 21, 1937: The patient is in excellent health. There is no drainage from either eye.

May 6, 1942: A letter from the parents says: "The patient is still in the best of health. She attends school and is getting excellent grades."

Sept. 5, 1942: The patient was seen and examined. She is in excellent health. The remaining tissues of each orbit appear healthy. There is no damage to the bony structure of either orbit.

CASE 16 (Hospital No. 74755): G. P., white male, age 6 weeks, was admitted Oct. 17, 1938. A cat's eye reflex was noticed by the parents one week prior to admission, in the left eye. The eye was enucleated, Oct. 18. The pathological report was "retinoblastoma. Definite evidence of infiltration of the optic nerve was not seen."

From Oct. 25 to Oct. 31, 1938, x-ray therapy was given lateral to the left orbit, 1176 r. The factors were as follows: 20 ma., 200 kv.p., 50 cm. distance, Thoraeus A filter, 6 × 6-cm. portal.

April 24, 1942: Letter from mother: "Gary is in excellent physical condition. He sees extremely well with his right eye and wears an artificial eye on the left."

CASE 17 (Hospital No. 74971): J. W., colored male, age 3 months, was admitted Nov. 1, 1938. One week before admission it was noticed that the color of the left eye had changed from a brown to a blue-gray. On examination of the left eye the cornea was found to be covered with a bluish haze. The eye was distinctly harder to palpation than was the

right. In the right eye there was a cat's eye reflex. Vision was not entirely gone. The diagnosis was bilateral advanced retinoblastoma.

On Nov. 2, the left eye was enucleated. Enucleation of the right eye was recommended, but was refused by the parents. Between Nov. 5 and Dec. 1 x-ray therapy was given to the lateral right orbit, with the following factors: ma. 20, kv.p. 200, distance 50 cm., Thoraeus A filter, portal  $10 \times 10$  cm. A total dose of 1,768 r was given.

*Dec. 6, 1938:* Examination under anesthesia shows no change in the appearance of the tumor in the right eye, following a series of x-ray treatments.

*Oct. 14, 1941:* The child was admitted on this date, approximately three years following the first observation. The parents stated that vision remained in the right eye until January 1941. Examination showed no recurrence of tumor in the left eye. The right eyeball protruded. A mass  $3 \times 4$  cm. was palpable over the right malar bone.

The patient complained of pain in his lower extremities, and x-ray examination showed extensive metastases in the lower half of each femur and in the neck of the right femur. Metastasis was also seen in the left humerus close to the upper epiphysis.

*Between Oct. 31 and Nov. 15, 1941,* x-ray therapy with factors as previously described was given. A total of 1,890 r was delivered to the right lateral orbit, and the same dose to the anterior aspect of each femur.

Enucleation of the right eye was done. A pathological report of retinoblastoma showing extensive necrosis and infiltration into the extraocular muscle and orbital tissue was made.

The patient was dismissed on Nov. 16, showing some relief of pain and moderate reduction of the tumor. He died at home on Jan. 11, 1942.

*CASE 18 (Hospital No. 80969):* M. B., white male, age 9 months, was admitted Nov. 10, 1939. A large intraocular tumor was discovered in the left eye five weeks prior to admission. A smaller tumor was seen in the right eye. The left eye had been enucleated elsewhere. The pathological report, from the Army Medical Museum, was "retinoblastoma." In the right eye was a flat, slightly elevated, whitish mass arising from the temporal aspect of the retina.

It was deemed advisable to administer x-ray therapy to both orbits. From Nov. 16 to Dec. 6, 1939, a daily treatment was given, alternating between the two orbits. The factors used were as follows: 20 ma., 200 kv.p., 50 cm. distance, Thoraeus A filter,  $10 \times 10$ -cm. portal, 166 r (measured in air) daily dose, half-value layer 1.675 mm. Cu. A total dose of 1,328 r was administered to each lateral orbital area.

On Feb. 19, 1940, examination revealed the following findings: "Under anesthesia definite regression is seen. Instead of the one large mass there are three smaller white areas that seem rather definitely defined."

Examination by Dr. Kevin Curran, March 28, 1940, was reported as follows: "Only three tiny yellowish-white scars mark the place where there were retinoblastoma growths, inferior to the optic nerve."

From March 2 to March 20, 1940, another series of x-ray treatments, similar to that previously described, was given.

From Oct. 25 to Nov. 4, 1940, a total dose of 1,224 roentgens was given to the right lateral orbit. Factors used were as previously described.

*June 18, 1941:* The mother states that the child's sight has improved considerably since the last dismissal. Examination of the right eye by Doctor Curran is reported as follows: "In the lower temporal region below the macula are seen several pin-head-sized yellowish masses. These appear to be scarred and inactive. There are some spots of patchy choroiditis above the small granules. We believe this eye to be cured at the present time."

The child died of bronchopneumonia in December 1941. The vision was good at the time of death.

*CASE 19 (Hospital No. 83542):* B. D., white male, age 3 1/2, was admitted April 18, 1940. About one month prior to admission the patient began to hold things close to his eyes in order to see them. Examination by a local doctor revealed bilateral tumor.

Examination of the eyes under anesthesia showed "a large retinoblastoma inferotemporal to the right optic nerve" and on the left "a flat retinoblastoma inferotemporal to the optic nerve and apparently including the nerve."

From April 23 to May 11, 1940, a dose of 1,117 r was administered to each lateral orbit. Factors were as follows: kv.p. 200, distance 50 cm., Thoraeus A filter, half-value layer 1.675 mm. Cu, portal  $10 \times 10$  cm. One hundred seventeen roentgens were administered at each treatment. The treatment was alternated between the orbits.

*Jan. 27, 1941:* Letter from mother: "Bobby Lee sees a great deal better than when he was in the hospital."

*May 27, 1941:* Readmission. Patient has no vision in the right eye but can distinguish and count fingers with the left eye at four feet.

*June 2, 1941:* The right eye was enucleated. Pathological report: "Retinoblastoma or neuroepithelioma of the eye."

*May 29-June 18, 1941:* A total dose of 1,260 r was given to the left lateral orbit; the same amount was given to the right lateral orbit. Factors were the same as in the last series of treatments except for the fact that the portal was reduced to  $6 \times 6$  cm.

*Jan. 14, 1942:* Readmission. Vision is improved in the left eye to the point that the patient can see writing on paper.

*Jan. 17-Feb. 4, 1942:* A dose of 1,120 r was given to the left lateral orbit and 480 r to the right lateral orbit.

*June 15, 1942:* Readmission. The vision on the



Fig. 1. Case 20: Recurrent retinal glioma protruding from the left orbit.

left has improved. The patient counts fingers readily and can recognize objects at any distance. Examination was done by Doctor Curran. He reported as follows: "Lesion in the left fundus consists of flat circumscribed white patches."

*June 15-July 3, 1942:* X-ray therapy was given to the left orbit following the technic of Martin and Reese with modifications; 1,980 r were given to the lateral left orbit, medial left orbit, and inferior left orbit. Factors were as follows: 200 kv.p., distance 44 cm., filter 1 mm. Cu plus 1 mm. Al. Each individual dose was 420 r. Treatment was given daily, alternating between the three areas. The portal was circular, 3 cm. in diameter.

*July 1, 1942:* Examination (by Dr. Desmond Curran) on dismissal shows a vision in the left eye of 20/50. The media is clear; no actual lesions are noted.

**CASE 20** (Hospital No. 94475): D. C., white male, age 4, was admitted Nov. 17, 1941. The parents were told in January 1940 that the child had a tumor in the left eye. On Feb. 22, 1940, the eye was removed in another hospital. In the summer of 1941 recurrence was observed. The patient was given four x-ray treatments before admission to our hospital.

Examination showed a hard mass protruding from the left orbit. It was the size of a large orange and ulcerated (Fig. 1).



Fig. 2. Case 20: Regression of retinal glioma following x-ray therapy.

X-ray therapy was administered to the left orbit as follows: lateral left orbital mass, 1,470 r; medial left orbital mass, 1,470 r; superior left orbital mass, 985 r; inferior left orbital mass, 985 r. Factors were as follows: kv.p. 200, distance 50 cm., Thoraeus filter, port 6 X 6 cm., half-value layer 1.675 mm. Cu. The daily dose was 210 r, the various areas being treated alternately. The child was dismissed Dec. 28, 1941, with considerable regression of the mass (Fig. 2).

*Feb. 4, 1942:* Readmission. There has been progressive regression of the tumor, though it still holds the eyelids apart. X-ray therapy was resumed on Feb. 13.

It was observed that the child could not see out of the right eye. Examination by Doctor Curran revealed a normal fundus. It was his opinion that the tumor had extended to the chiasma. From Feb. 5 to March 27 x-ray therapy was administered as follows: right anterior skull, 1,292 r; left lateral orbit, 630 r; right lateral skull, 2,380 r directed to the optic chiasma; left lateral skull, 2,380 r. Factors used were as previously described.

On March 25 a septic temperature developed, which persisted until death on April 27. During the last two weeks of life the child was unconscious and took but little fluid.

A summary of the autopsy findings is as follows: "There is retinoblastoma in the posterior left orbit



and rather widespread invasion of the meninges due to retinoblastoma. The brain stem and cerebellum are invaded by malignant tissue. Other significant findings are degenerative in type." No evidence of regional metastasis was observed.

#### SUMMARY

Of our 20 cases, half of which were bilateral, 15 received radiation therapy supplementary to surgery. Seven of the 15 patients are living. One treated by enucleation alone is living. Three of those who had evidence of tumor in each eye are living with vision in the remaining eye, the other eye having been enucleated. One of these (Case 19) who was treated with x-rays and who has been followed for a period of over two and a half years has 20/50 vision in the remaining eye. One patient (Case 13) was treated with radium needles imbedded about the periphery of the remaining eye. He has been followed for seven years. A cataract has developed which is being treated. At present he can distinguish trees and other large objects. This child, incidentally, had extensive infiltration into the optic nerve of the enucleated eye. The third patient (Case 4), who received one x-ray treatment and later was treated by small radium packs, is alive sixteen years and a half following treatment, with 3/60 vision. One child (Case 18) treated with x-rays showed almost complete regression of the tumor in the remaining eye. Unfortunately he died of bronchopneumonia after having been followed for over two years. One patient (Case 9) who had a recurrence in the stump of the nerve five months after enucleation is now a nine-year cure. He was treated with interstitial radiation of the optic nerve head.

#### CONCLUSION

Radiation therapy of retinoblastoma as a supplement to surgical removal is advocated. Routine implantation of radium adjacent to the optic nerve stump at the time of surgical removal of the eyeball, regardless of the pathological report, is considered a logical procedure.

Some cases of bilateral retinoblastoma may be cured, with a degree of preservation of vision, by radiation therapy of the remaining eye. Our experience has been largely with radium therapy. We feel that the treatment of the remaining eye with x-ray therapy, as advocated, is more satisfactory than the use of interstitial radiation as used in some of our earlier cases.

It seems possible, in view of the demonstrable sensitivity of retinoblastoma to large doses of radiation, that an early tumor may be treated and cured by radiation alone. Conservation of life and vision in both eyes is the perfect result to be anticipated. If such a case has been reported, we are not aware of it, but if an early diagnosis can be made, it seems a possibility of the future.

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#### BIBLIOGRAPHY

1. ADAM, C.: Statistisches, Klinisches und Anatomisches über das Glioma retinae. *Ztschr. f. Augenh.* 25: 330-350, 1911.
2. Annual Report of the Division of Ophthalmic Pathology of the American Registry of Pathology at the Army Medical Museum. *Trans. Am. Acad. Ophth. & Otol.*, 1934. Quoted from Pack and Livingstone: *Treatment of Cancer and Allied Diseases*, Vol. 3.
3. AXENFELD, T.: Doppelseitiges Glioma retinae und intraokulare Strahlentherapie. *Klin. Monatsbl. f. Augenh.* 17: 426-428, 1914.
4. BORLEY, WM. E.: Discussion of paper by Martin and Reese (12).
5. HILGARTNER, H. L.: Report of a Case of Double Glioma Treated with X-Ray. *Texas M. J.* 18: 322-323, 1903.
6. HIRSCHBERG, J.: Anatomische Untersuchungen über Glioma Retinae. *Arch. f. Ophth.* 14 (2 Abth.): 30-102, 1868.
7. JANEWAY, H. H.: Therapeutic Use of Radium in Diseases of the Eye. *Arch. Ophth.* 49: 156-174, March 1920.
8. KNAPP, A.: Bilateral Glioma: Report of a Case Unsuccessfully Treated with Radium. *Arch. Ophth.* 49: 575-584, November 1920.
9. KUSAMA, KANAME: X-ray Treatment of Retinal Glioma. *Am. J. Ophth.* 2: 636-650, 1919.
10. LEBER, T.: Die Geschwulstbildungen der Netzhaut in Graefe-Saemisch: *Handbuch der gesamten Augenheilkunde*, 2nd ed., Leipzig, W. Engelmann, 1916. Vol. 7, Chapt. 15.
11. MARTIN, H. E., AND REESE, A. B.: Treatment of Retinal Gliomas by the Fractionated or Divided Dose Principle of Roentgen Radiation: Preliminary Report. *Arch. Ophth.* 16: 733-761, November 1936.
12. MARTIN, H. E., AND REESE, A. B.: Treatment of Retinoblastoma (Retinal Glioma) by a Combination of Surgery and Radiation. *Tr. Am. Acad. Ophth.* (1940) 45: 70-97 March-April 1941.

13. MOORE, R. F., STALLARD, H. B., AND MILNER, J. G.: Retinal Glioma Treated by Radon Seeds: *Brit. J. Ophthalm.* 15: 673-696, December 1931.
14. PEIFFER, R. L.: Roentgenographic Diagnosis of Retinoblastoma. *Arch. Ophthalm.* 15: 811-821, May 1936.
15. REESE, A. B.: Extension of Glioma (Retinoblastoma) into the Optic Nerve. *Arch. Ophthalm.* 5: 269-271, February 1931.
16. SCHOENBERG, M. J.: Case of Bilateral Glioma of Retina Apparently Arrested in the Non-Enucleated Eye by Radium Treatment. *Arch. Ophthalm.* 48: 485-488, September 1919.
17. SCHOENBERG, M. J.: Case of Bilateral Glioma of the Retina, Cured in the Non-Enucleated Eye by Radium Treatment. *Arch. Ophthalm.* 56: 221-228, May 1927.
18. STALLARD, H. B.: New Technique for the Application of Radon Seeds to the Sclera in the Treatment of Glioma Retinae. *Brit. J. Ophthalm.* 22: 604-608, October 1938.
19. VERHOEFF, F. H.: Glioma Retinae Treated by X-Rays with Apparent Destruction of the Tumor and Preservation of Normal Vision. *Arch. Ophthalm.* 50: 450-456, September 1921.
20. WINTERSTEINER, HUGO: Das Neuroepithelioma Retinae, Leipzig and Vienna, Franz Deuticke, 1897.

#### DISCUSSION

Lewis G. Allen, M.D. (Kansas City, Kans.): The first tragic feature of this disease, of course, is the disease itself. The second is the fact that the patient is a child. Finally, subsequent loss of vision may almost universally be expected.

Doctor Tice's series of cases is unusual in that 50 per cent showed bilateral involvement. I agree with Doctor Tice that the adequate treatment of retinoblastoma should be pursued even at the cost of the sight in the affected eye. While he has pointed out that spontaneous cures may occasionally occur, their incidence is too infrequent to modify our judgment completely.

The character of the extension of retinoblastoma is singular in that the tendency of the tumor is to extend along the optic nerve. This property renders the plan of treatment a little different than that presented in most tumors. Because in a large number of cases there is invasion of the optic nerve posterior to the lamina cribrosa, the treatment of the nerve stump seems essential and for this reason

dependence on enucleation alone would seem unreasonable.

The work of Martin and Reese introduces the thought that surgery, either alone or in combination with irradiation, may be challenged.

It would appear that the employment of radium needles of low filtration as used by Doctor Tice is rational in that it is desirable to deliver a relatively intense dose in a comparatively short time and at a short distance. Therefore, the choice of low filtration needles, with their caustic effect, has an advantage.

Doctor Tice has reported no case in which excess irradiation of the orbit was obtained, there being no instance of adjacent bone necrosis or of meningitis.

The sequelae to either radium or roentgen therapy—namely, keratinization of the conjunctiva and cornea, glaucoma, cataract, and atrophy of the globe—are the same sequelae we are accustomed to seeing in extensive malignant lesions of the face where heavy irradiation is employed.

The results in this series, particularly in cases showing bilateral involvement, are impressive. Of 10 patients there were 4 living, 4 dead, and 2 not followed. Of the 10 patients with unilateral disease, 4 are living, 5 dead, and 1 not followed. This gives an approximately identical cure rate in that 40 per cent of each series are still alive. While this percentage is not impressively high, if one considers the seriousness of the lesion when untreated the results are commendable.

Ira I. Kaplan, M.D. (New York): I would like to give Doctor Tice a little idea of the treatment we have been giving one of Doctor Schoenberg's patients, a young child with one eye enucleated and beginning involvement of the remaining eye. We irradiated the remaining eye intensively, applying castor oil under the lid before irradiation and permitting it to remain during treatment. This limited the rapidity with which post-irradiation changes occurred; that is, cataract took much longer to develop. In irradiating any lesion about the eye, we now apply a few drops of sterile castor oil under the lid, with consequent decrease of radiation damage to the sclera.

there will usually be some bone reaction in its immediate vicinity, such as spiculation or atrophy. A not uncommon fallacy is to consider large vessel channels the result of intracranial hemorrhage. Large vessel channels in a patient receiving a head trauma may be a factor in the production of hemorrhage, but inasmuch as most dural and subdural hemorrhages are from vessels within the meninges, it is readily understood that vessels within the diploe will have relatively little to do with the production of such hematomata.

Our chief interest in large vessel channels is to be able to warn a neurosurgeon that such vessels are in the operative field, or to be better able to predict the probable course of infection should a fracture or wound become infected. To be considered really hypervascular, an area must be hypervascular in comparison to other parts of the same head, and not in comparison to whatever model we may have set up as our standard.

Another anatomical area in which we may find difficulty in recognizing an abnormality is the diploe or middle table of the calvarium. The diploe may be coarse or fine, plentiful or sparse, evenly distributed or irregular in its distribution without being of any pathological significance. Not infrequently the diploe in the parietal areas will differ considerably from the same structure in the frontal or occipital region in the same skull, so that we must be familiar with the normal variations in order to be able to exclude such pathological conditions as osteitis deformans, osteofibrosis, infections, or other conditions due to nutritional disturbances.

Normal fine diploe will appear as a lace-like net within the calvarium. It will be clearly delineated, as are small uninfected mastoid cells, and will be continuous throughout the bone, being interrupted only by vessel channels and perhaps an occasional convolutional impression. It is this type of diploe that can at times mislead one into considering the appearance of the calvarium as granular, thus arousing suspicion of the presence of basophilism,

hyperparathyroidism, or other disturbances of calcium metabolism. In such pathological conditions, the inner and outer tables, together with the bones of the base, would be lacking in bone calcium and the diploe would stand out in greater contrast than would be the case in the presence of normally calcified calvarial tables. It is true that the changes mentioned are in degree only and therefore at times offer us one of our most difficult problems of differential diagnosis. If, however, we have a clear clinical picture of the patient before us, our problem will be somewhat simplified.

The coarse type of diploe, often limited to one bone or even part of a bone, may suggest bony spiculation, porosity, or fibrotic changes. Upon careful stereoscopic study it will be seen that normal diploe, however coarse, will be neatly encased within the inner and outer tables; there will be no roughening of the cortex, no increase in vascularity except, perhaps, the presence of venous lakes in conjunction with diploic veins, no fusiform diploic swelling, best demonstrated in tangential views, and no areas of destruction of the overlying or underlying tables. In the presence of disease, the trabecular configuration and regularity will be disturbed and disorganized.

Not infrequently, in lateral views of the skull, we will see fine lines within the calvarium at various angles to the plane of the vault. To the unwary these lines may suggest bony spiculations or even striations of the type seen in the erythroblastic anemias. The lines must be studied carefully in order to identify them and rule out pathological possibilities. They are caused by a particularly well serrated sagittal suture and will have a healthy bone appearance. An anteroposterior or postero-anterior view will usually help considerably in recognizing the true significance of these at times puzzling lines.

The sutures are occasionally confusing and may be sources of error in diagnosis. We must remember that the occipito-sphenoidal suture may occasionally remain

open until the age of about twenty years. It must not be considered evidence of a fracture, an easy pitfall if trauma has occurred. The short anterior branches of the inferior portions of the lambdoid sutures are often found to be asymmetrical. One will be seen to be less well approximated than the other. This again is easily misinterpreted as evidence of a fracture. It is well to remember that, to all intents and purposes, we can consider the skull as a sphere; it then becomes evident that to separate a small area without depression or splintering would be very difficult and would deform the entire sphere. Hence, when we see an area of real separation and on careful study find no depression, atrophy, or comminution, it is highly probable that we are dealing with a normal condition or a normal variant rather than an actual abnormality. Double suture lines must not be considered as evidence of fracture. The suture lines of the inner and outer tables occasionally do not coincide, so that an extraneous line may appear to run through the suture. A careful study of stereoscopic films will usually permit us to evaluate properly such an anomaly.

There are several anatomical variants which can easily mislead us unless we are careful, such as nature's trick of occasionally permitting the malar bone to originate from two or three centers of ossification. This type of development can easily simulate fractures, especially if we suspect trauma to that portion of the skull. A congenital lack of a superior orbital plate may appear very significant to the unwary, but a careful study of the margins of the "defect" will show that it is composed of healthy bone, which should dispel our fears. We must bear in mind, when examining skulls, that various anatomical anomalies can and do occur.

Convolutional impressions are often misinterpreted as evidence of intracranial pressure when in reality they are quite innocuous. There seems to be a widespread impression that whenever the inner table of the vault presents the appearance of "beaten silver," whether the likeness is

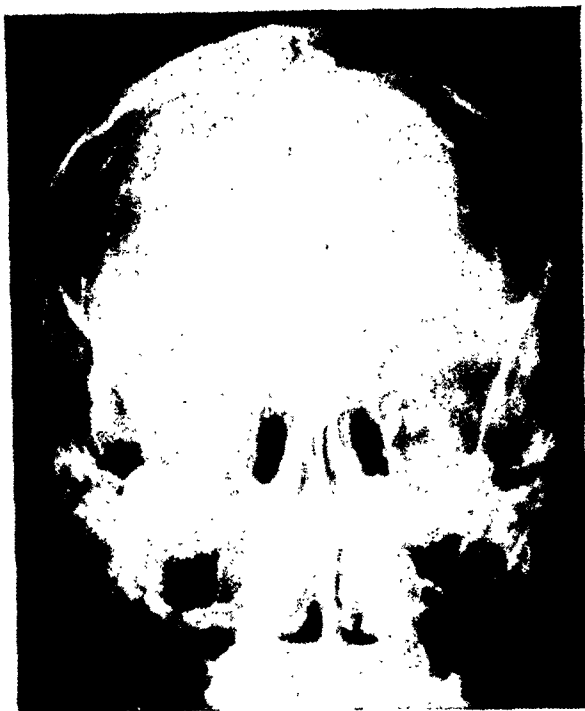


Fig. 3. Double suture line. This is not to be confused with a fracture passing through the suture.

exact or remote, it indicates an increase of intracranial pressure. First of all, we must be sure that we are dealing with real convolutional impressions. To be actually what they seem, they must conform to the anatomical configurations of the cerebral convolutions; otherwise, they are not convolutional impressions and are probably caused by some such condition as lacunous osteogenesis, dysostosis cleidocranialis, or even leptomeningeal cysts, all of which are pathological or variants of clinical significance.

True convolutional impressions are frequently seen in young people and occasionally in older patients in the temporal and occipital regions, without being of pathological significance. In fact, the number and depth of the convolutional digitations may vary widely within normal limits, and for this reason we must be careful not to misinterpret their significance. If the convolutional markings are the result of an increase of intracranial pressure, the interconvolutional ridges will lack calcium. They will appear atrophic and it is highly probable that other signs of increased pres-

sure will be recognizable, since deepening of the convolutional markings does not become evident until the pressure has been elevated for some time. Too many factors enter into the production of convolutional markings to make it possible to state how long after the onset of pressure they will be demonstrable in the film, but it seems safe to say that on an average, in the case of a child, several weeks would elapse, and in an adult at least two or three months, depending upon the thickness of

Another frequent source of error in intracranial diagnosis is the misinterpretation of a demineralized sella turcica as evidence of pressure atrophy, when actually it may be due to a congenital lack of bone calcium or to an abnormality of calcium metabolism of systemic origin, or to a normally thin bone. This again emphasizes the importance of always considering the general physical status of the patient when interpreting roentgenographic changes. We should remember that the

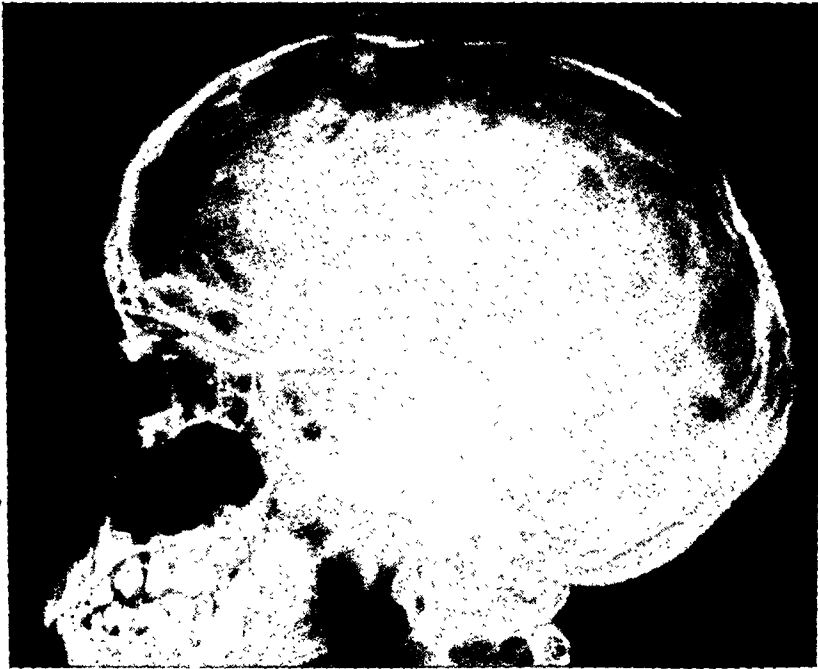


Fig. 4. Convolutional impressions not due to an elevation of intracranial pressure. Note the clarity of outline of the interconvolutional ridges.

the skull. An increase in depth and number of these markings can also occur in the presence of some of the malacic disturbances of bone which involve a variation of calcium metabolism. Often we will find the convolutional impressions delineated by healthy looking bone forming the interconvolutional ridges. This may well be of historical interest and indicate that, at one time in the past, pressure was a factor, or some metabolic or nutritional disorder played a leading role, but has since become corrected. Therefore, we must carefully weigh the evidence before interpreting convolutional digitations as being of clinical significance.

roentgenogram, in the final analysis, is but a link in the chain of evidence, albeit an important one. In order to differentiate between demineralization due to pressure and that due to metabolic disturbances of systemic origin, we must carefully study the cortex of the bone forming the posterior clinoid processes and dorsum sellae, since it is in this portion of the skull, as a rule, that atrophy first becomes apparent. If the cortex is less dense than the cortex of the adjacent bony structures, particularly if it is less dense than the central portion of the bone, we are almost certainly dealing with atrophy. This change may at times be difficult to recognize, particularly if it

is just beginning and if the dorsum sellae is invaded by a sphenoid air cell. Usually it can be recognized, however, if we are careful to compare the entire bony structure of the skull with that of the sella turcica, bearing in mind that the patient's general condition may be the cause of a demineralization which would not primarily affect the cortex.

It is well to remember, as pointed out above, that in the sella turcica it is the posterior clinoids and dorsum sellae that

usually under such conditions cortical atrophy might be difficult to recognize; in fact it does not develop as readily as it would if the floor were thin.

Symmetry of the skull is never perfect, so that we must be wary in interpreting asymmetry as abnormal. This is particularly true of the petrosa. About 10 or 15 per cent of skulls show congenitally asymmetrical petrous pyramids, one being aerated in a comparatively normal manner while the other contains very few air cells.



Fig. 5. Convolutional impressions due to an increase of intracranial pressure.

usually first show signs of pressure atrophy; then the floor will lose bone calcium, and lastly the anterior clinoids and tuberculum sellae will become atrophic. This is because the anterior clinoids are somewhat protected by the diaphragma sellae. A consideration of this chain of events will not infrequently permit us to state whether or not we are dealing with an early process. We must not be misled in making such an estimate in the presence of a massive floor under which there are no air cells. Obvi-

Usually the one with no air cells will be smaller, so that we will have a clue as to the real situation and not call such a condition evidence of old infection, as is so often done. Asymmetry may, however, be of considerable clinical significance, as when it is the result of agenesis or hypoplasia of one cerebral hemisphere. This condition is seen at times in patients suffering from some form of convulsive disorder. Dyke, Davidoff, and Masson a few years ago described this condition and



Fig. 6. Lacunous osteogenesis (Lückenschädel). The defects in the bone are not due to convolutional impressions.

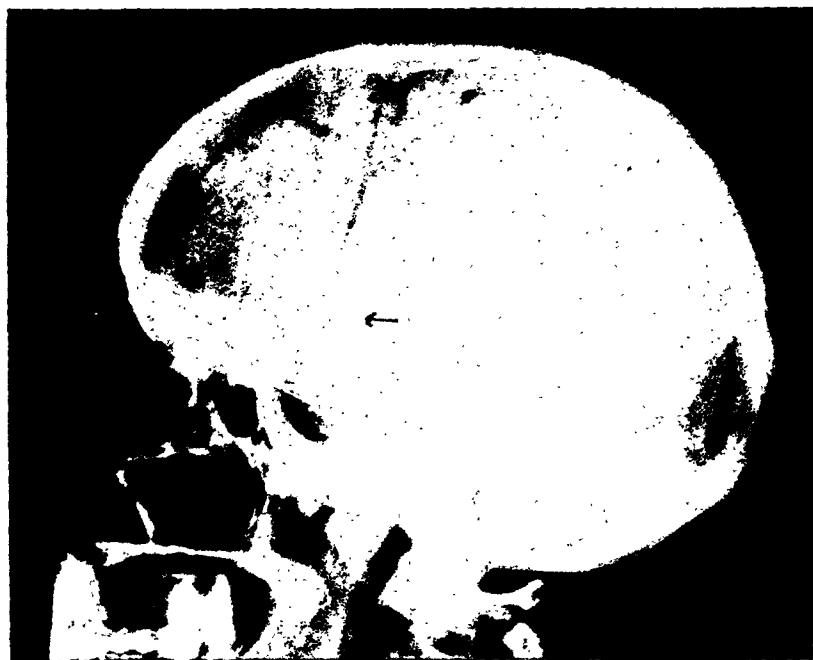


Fig. 7. An interesting anomaly consisting of a canalization of the middle meningeal vessel channel.

demonstrated the cerebral asymmetry by encephalography. This particular type of asymmetry is characterized by large supraorbital ethmoid cells on one side, which have developed at the expense of the cranial capacity. The petrous pyramid on the same side will be larger and the ridge higher than its counterpart of the opposite side, and in addition the calvarium will usually be thicker on the side of the smaller hemisphere. Asymmetry of the frontal cells is not of much importance, but the size and shape of the frontal cells may offer us a clue as to the endocrine status of the patient.

The mistake must not be made of drawing conclusions from a study of only one part of the skull. Every structure must be carefully studied and evaluated with reference to the whole. In this way only can we learn all that the films can teach us about the individual in question. Above all, we must not make the mistake of concluding our search after finding one abnormality, for not infrequently the same skull will contain several, and all or none may be of clinical significance.

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#### BIBLIOGRAPHY

- BAUMM, H.: Der Lückenschädel als Ursache für das intrauterine Absterben des Kindes. *Zentralbl. f. Gynäk.* 54: 1938-1939, Aug. 2, 1930.
- BROWNING, W.: Veins of the Brain and Its Envelopes. Brooklyn, F. B. O'Connor, 1884.
- CAMP, J. D.: Normal and Pathological Anatomy of Sella Turcica as Revealed at Necropsy. *Radiology* 1: 65-73, October 1923.
- CLARK, W. E. LE GROS: On the Pacchionian Bodies. *J. Anat.* 55: 40-48, 1920-21.
- DAVIDOFF, L. M.: Convolutional Digitations Seen in the Roentgenograms of Immature Human Skulls. *Bull. Neurol. Inst. New York* 5: 61-71, August 1936.
- DYKE, C. G.: Indirect Signs of Brain Tumor as Noted in Routine Roentgen Examinations; Displacement of the Pineal Shadow; Survey of 3,000 Consecutive Skull Examinations. *Am. J. Roentgenol.* 23: 598-606, June 1930.
- DYKE, C. G., DAVIDOFF, L. M., AND MASSON, C. B.: Cerebral Hemiatrophy with Homolateral Hypertrophy of the Skull and Sinuses. *Surg., Gynec. & Obst.* 57: 588-600, November 1933.
- EARL, G.: Limitations and Possibilities of X-ray Skull Diagnosis. *Journal-Lancet* 33: 307, 1913.
- ELSBERG, C. A., AND SCHWARTZ, C. W.: Increased Cranial Vascularity in Its Relation to Intracranial Disease. *Arch. Neurol. & Psychiat.* 11: 292-307, March 1924.
- ENGSTLER, G.: Ueber den Lückenschädel Neugeborener und seine Beziehung zur Spina bifida. *Arch. f. Kinderh.* 40: 322-329, 1901-05.
- GOLDBAMER, K.: Normale Anatomie des Kopfes im Röntgenbild. Leipzig, Georg Thieme, 1930.
- NAFFZIGER, H. C.: Method for Localization of Brain Tumors—the Pineal Shift. *Surg., Gynec. & Obst.* 40: 481-484, April 1925.
- SCHWARTZ, C. W.: Recognition of Some Forms of Intracranial Lesions. *Am. J. M. Sc.* 190: 220-225, August 1935.
- SCHWARTZ, C. W.: The Normal Skull from a Roentgenologic Viewpoint. *Am. J. Roentgenol.* 39: 32-42, January 1938.
- SCHWARTZ, C. W.: Anomalies and Variations in the Normal Skull from a Roentgenological Viewpoint. *Am. J. Roentgenol.* 42: 367-373, September 1939.
- SOSMAN, M. C.: Radiology as an Aid in Diagnosis of Skull and Intracranial Lesions. *Radiology* 9: 396-404, November 1927.
- VASTINE, J. H., AND KINNEY, K. K.: The Pineal Shadow as an Aid in the Localization of Brain Tumors. *Am. J. Roentgenol.* 17: 320-324, March 1927.





# Developmental Thinness of the Parietal Bones<sup>1</sup>

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A VARIATION IN the appearance of the parietal bones encountered during the examination of roentgenograms of the head is a condition which is probably best described as "developmental thinness of the parietal bones." By this is meant the presence of an area near the superior margin of both, or less commonly one, of the parietal bones which appears to interrupt the normal smooth convexity of the parietal eminence and form a shallow depression involving about a fourth of the area of the parietal bone. It is manifested by a partial or complete absence of the diploe of the calvarium at the site and by a corresponding thinness of the skull in the involved portion. Less often the defect may assume the configuration of a parietal groove or sulcus. Known to anatomists and pathologists, it has escaped the attention of roentgenologists, as judged from the scant mention it has received in roentgenologic literature. In our experience the condition is fairly common and it is of interest because it may be confused with pathologic conditions.

A number of names have been given to this finding. Among these are "Involutionsskrankheit" (Virchow), "senile atrophy" (Humphry), "symmetrical depressions" (Shepherd), "symmetrical atrophy" (Hollander), "symmetrical thinning" (Smith), "parietal impressions" (Piersol), and "symmetrical thinness of the parietal bones" (Greig).

Excellent reviews of the subject have been made by Chiari and also by Greig.

To our knowledge, however, little has been written concerning the roentgenologic aspects of developmental parietal thinness. Redlich and Schüller, as early as 1910, described a parietal defect found in a roentgenogram of the head, which probably was developmental parietal thinness. In America, Holmes and Ruggles, Sante, and Pancoast, Pendergrass and Schaeffer have mentioned the condition, noting its rarity. Moore published a report of a case in 1929. Kasabach and Dyke included at least one case of developmental parietal thinness under the title of "osteoporosis circumscripta" in a report made in 1932. In the discussion of a paper on enlarged parietal foramina by Pepper and Pendergrass in 1936, Sosman and Pepper mentioned the change we speak of. Occasional reports of cases can be found in the foreign literature.

There are essentially two types of developmental parietal thinness, the flat type and the grooved type as seen in the postero-anterior projection. The involvement is usually bilateral and symmetrical; unilateral changes occur less often. An area of decreased density corresponding to the involved region is demonstrable in the lateral projection of the head. There is usually a smooth progressive thinness from the periphery of the involved area to its center. Typically, the diploe is lacking at the site of thinness. The external table is thinned and depressed. Some authors, among whom are Smith, Durward, Pancoast, Pendergrass and Schaeffer, and Schmidt, think that the inner table may likewise be affected. In our cases of developmental parietal thinness, we did not find involvement of the inner table.

<sup>1</sup> Presented before the Radiological Society of North America at the Twenty-eighth Annual Meeting, Chicago, Ill. Nov. 30-Dec. 4, 1942.

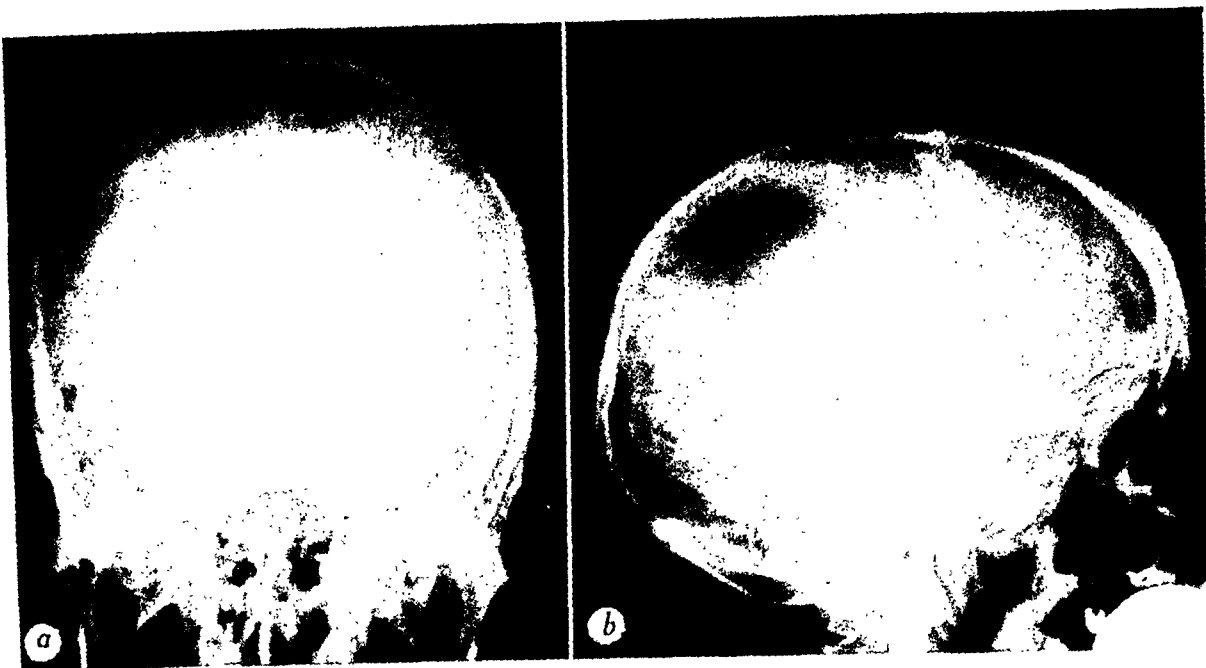


Fig. 1. Flat type of developmental parietal thinness: postero-anterior and lateral views.

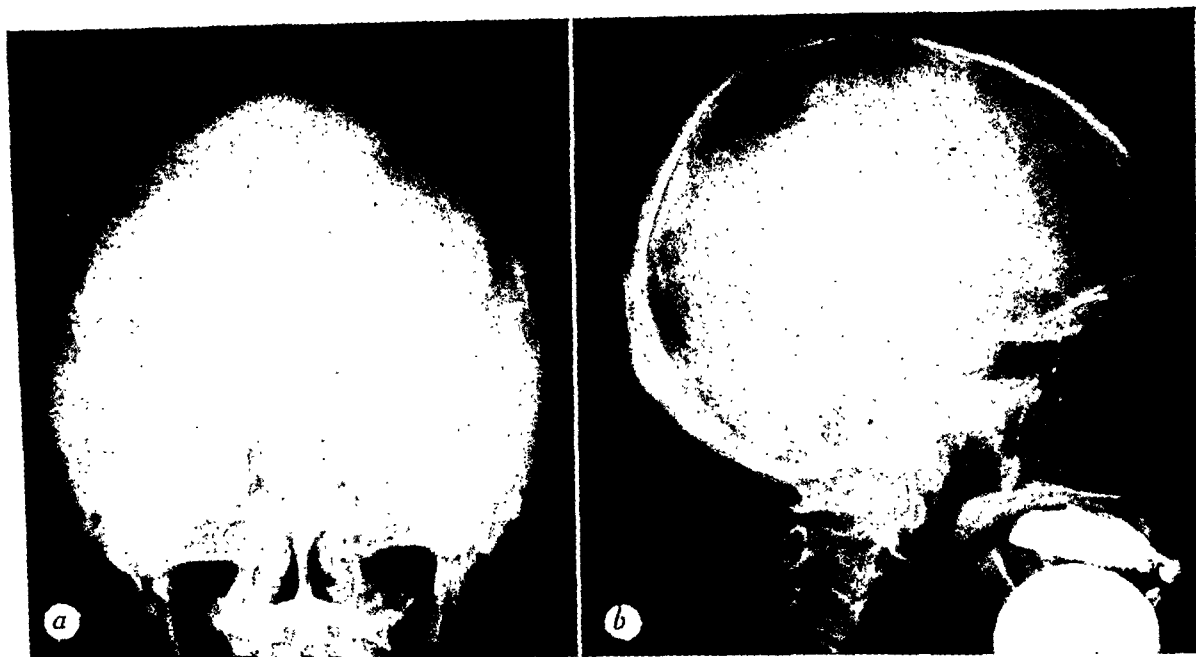


Fig. 2. Grooved or sulcus type of developmental parietal thinness: postero-anterior and lateral views.

It is not necessary to deviate from the conventional lateral and postero-anterior roentgenograms of the head to demonstrate this condition. One may, of course, show it better with tangential views over the involved portion of the skull. Often, better definition of the lack of diploic structure and the thinness can be obtained by

examining the roentgenogram by means of a small bright lamp instead of a roentgenographic viewing box.

We have reproduced in the accompanying illustrations, roentgenograms of the common types. The flat type is seen in Figure 1. The less common grooved or sulcus type of developmental parietal

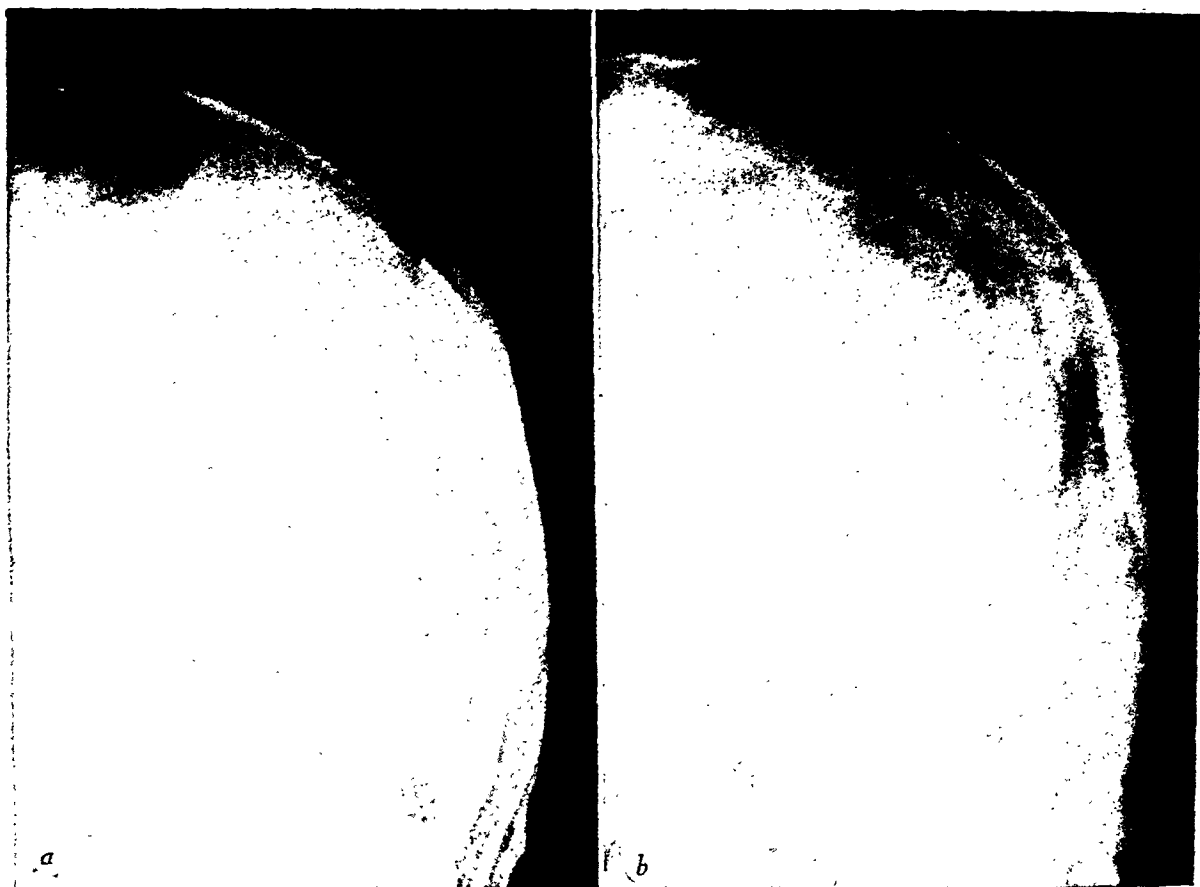


Fig. 3. Enlarged views (postero-anterior) of the flat (*a*) and the grooved (*b*) types of developmental thinness of the parietal bones.

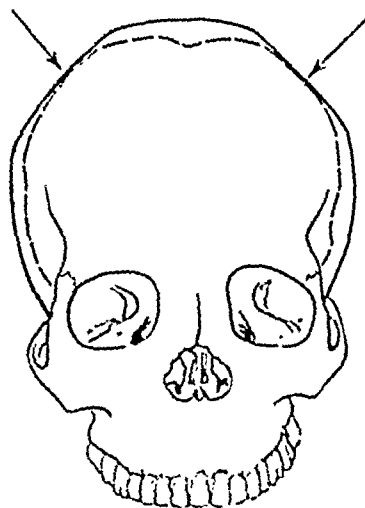
thinness is seen in Figure 2. Enlargements of the involved portions shown in Figures 1 and 2 are reproduced in Figure 3. Self-explanatory sketches of the changes in typical roentgenograms are given in Figures 4 and 5. An artist's conception of the changes as seen in a vertical view of the skull is also presented.

Virchow, Maier, and Rokitansky were pioneers in the pathologic concept of developmental thinness of the parietal bones. Of the more recent contributors to the pathology of the lesion, Schmidt presented his views concerning the condition in a work dated 1937. His description of the gross changes conforms to those given in previous paragraphs, except that he stated that in the extreme form the changes may involve the inner table of the calvarium and expose the dura. We did not observe this finding. According to Schmidt's descriptions of microscopic sec-

tions of these regions, the inner table of the skull is usually seen to be intact, the diploe is progressively thinned toward the center, the diploic spaces are diminished in size, and the external table is represented by a thin line of compact bone. The periosteum is intact on both sides of the calvarium.

Schmidt expressed the opinion that the changes encountered in developmental thinness of the parietal bones represent a special type of senile osteoporosis and that the condition is progressive. He did admit that it occurs in younger people, but considered that such cases belong to an exceptional type of senile osteoporosis. On the other hand, Greig, who has made rather extensive studies of museum skulls, believed the changes to be due to some altered physiologic process of bone, but considered the finding, as we know it, not progressive but static.

Flat type of thinness



Grooved type of thinness

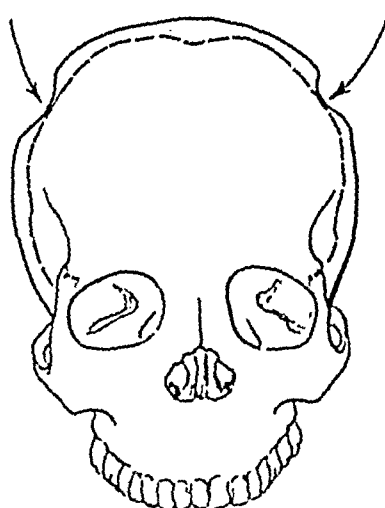


Fig. 4. Sketches of the changes of developmental thinness of the parietal bones.

Many hypotheses have been suggested in the past as to the causation of developmental thinness of the parietal bones, which are too numerous to mention at this time except for the idea, commonly accepted in the latter part of the nineteenth century, that it is a disease of old people, particularly of elderly women.

We have selected 119 examples of developmental thinness of the parietal bones from the files of the Section on Roentgenology of the Mayo Clinic for analysis. Variation in the appearance of the findings was noted. The bilateral flat type of developmental thinness of the parietal bones predominated, occurring 98 times in the 119 cases. Of the remaining cases, 9 were of the bilateral grooved type, 8 were of the unilateral flat type, and in 3 there were unilateral parietal grooves. One case was of a mixed type, presenting both a flat and grooved defect. Thus approximately 80 per cent of all of the roentgenograms studied in this analysis presented the bilateral flat type of developmental thinness of the parietal bones. In these, typically, the thickness of the calvarium at the site was reduced to about a half of the thickness of the adjacent uninvolved bone. In these typical cases, the affected area was 5 to 10 cm. in length in the sagittal plane as seen on the lateral roentgenogram and

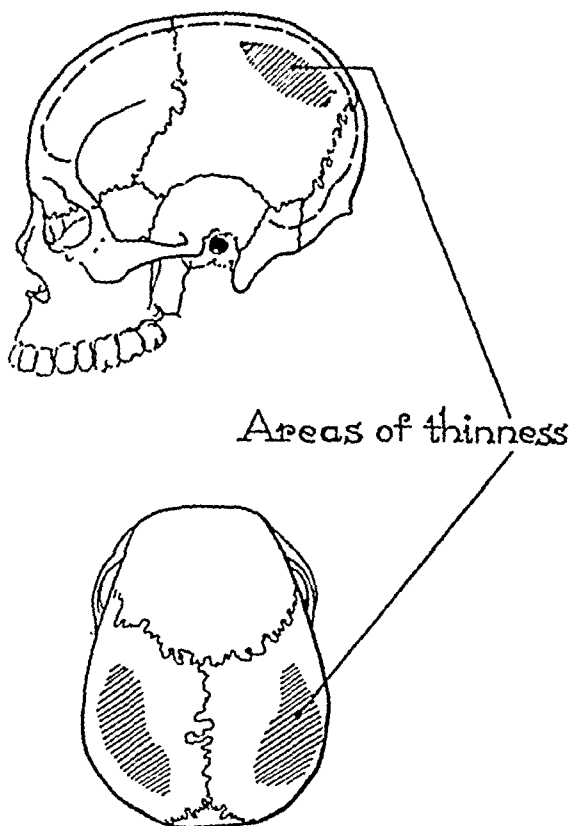


Fig. 5. Areas of thinness in the skull.

from 3 to 4.5 cm. in width. The areas were located above the superior temporal line, and the upper limits did not reach the sagittal suture in any case. The center of the area of thinness was usually midway

between the anterior and posterior borders of the parietal bone.

Durward found 5 cases of developmental thinness of the parietal bones in 1,000 museum specimens of Maori and Moriori skulls. Carrière noted the condition 4 times in 1,000 skulls and also found the lesion palpable in living subjects, with an incidence of one case in 406. We observed developmental parietal thinness in 0.46 per cent of all roentgenograms of the head during a two-year period, once in 217 cases. Indications for roentgenographic examination in these cases were rather general, mostly complementary to the neurologic examination, and the roentgenograms may represent a reasonably true sampling of patients.

Of the 119 cases of developmental thinness of the parietal bones, 80 occurred in males and 39 in females. This is in contrast to the teachings of the last century, when the condition was considered to be "an old woman's disease." Smith found equal sex distribution.

The median age for all cases of developmental thinness of the parietal bones was fifty-four years; for the group of female cases the median age was fifty-six years. Smith did not find any cases among subjects aged less than thirty years in his study of the skulls of Egyptians, and generally other reports rarely mention its presence in the younger age groups. Ten of the 119 patients in our series were thirty years of age or less. In one case the condition was seen in a four-year-old child, and slight but definite evidence of developmental thinness of the parietal bones was described in the roentgenograms of a nine-week-old infant.

An analysis of symptoms in the group of 119 cases was made. Since the cases were referred largely from the Section on Neurology, a large percentage of the patients had headache. We were not able to correlate this symptom with developmental thinness of the parietal bones, since the headache was due to other causes. This was also true of vertigo, tinnitus, and psychic symptoms. Other clinical points,

such as a history of injury and findings of the general physical examination, varied consistently.

The changes of developmental parietal thinness were palpable on examination in those patients whom we had an opportunity to see.

Two cases bearing on controversial points were included in this study. A woman, aged forty-three years, who had a rather marked degree of the flat type of bilateral parietal thinness had presented herself for examination four years before. Comparison of roentgenograms taken four years apart did not reveal any appreciable change in the degree of involvement. This, of course, is not conclusive evidence against the progressive nature of the condition; we merely cite it as an interesting observation. Another woman, aged seventy-three years, with whom we spoke recalled that her mother had likewise had grossly palpable bilateral parietal thinness. Since the condition is not familiar to most physicians and patients are rarely aware of any change in the contour of their calvaria, our attempt to determine any familial tendency except in the foregoing instance did not produce any definite results.

Thus, as far as we know, developmental thinness of the parietal bones is clinically not very important. It appears to be due to diploic dysplasia. In diagnostic roentgenology the lesion does assume a role of importance in so far as it may be misinterpreted as some other condition, as osteolytic metastatic carcinoma, myeloma, lymphomatous involvement of the calvarium, xanthomatosis, epidermoid tumor (cholesteatomas), osteoporosis circumscripta, enlarged biparietal foramina, secondary changes of a neoplasm of the scalp or inflammatory lesion of the scalp, osteomyelitis, postoperative changes, trauma, and localized absorption of bone due to unknown causes. The characteristics of these other conditions need not be reviewed here.

We have chosen to describe our findings in this series of 119 similar and related parietal lesions as "developmental thinness of the parietal bones" in contrast to

"symmetrical thinness," because of its occurrence in younger age groups than ordinarily described, and have dropped the term "symmetrical" since in a significant number of our cases the changes were unilateral. We have subscribed to the hypothesis of the static nature of this variation, so far as we designate it as "thinness" rather than "thinning," and are of the opinion that it is not progressive, since our younger patients displayed degrees of involvement similar to those of the older groups. Further, we did not find any cases in which there was thinness of such a degree as to be classed as a parietal foramen. We are familiar, as are others (Paterson and Lovegrove), with this latter variation, the so-called biparietal foramina, and feel that it is unrelated.

Remembering the roentgenographic characteristics of developmental thinness of the parietal bones, there should be no difficulty in recognizing it. We feel that its greatest significance is in knowing it as an incidental variation which might be confused with a pathologic change in the calvarium.

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#### REFERENCES

- CARRIÈRE, J.: Quoted by Greig, D. M.  
 CHIARI, H.: Zur Kenntnis der "senilen" grubigen Atrophie an der Aussenfläche des Schädels. *Virchows Arch. f. path. Anat.* 210: 425-433, 1912.  
 DURWARD, ARCHIBALD: A Note on Symmetrical Thinning of the Parietal Bones. *J. Anat.* 63: 356-362, April 1929.  
 GREIG, D. M.: On Symmetrical Thinness of the Parietal Bones. *Edinburgh M. J.* 33: 645-671, November 1926.  
 HOLLANDER, B.: Quoted by Greig, D. M.  
 HOLMES, G. W., AND RUGGLES, H. E.: *Roentgen Interpretation*. Lea & Febiger, 5th ed. 1936.  
 HUMPHRY, G. M.: Quoted by Greig, D. M.  
 KASARACH, H. H., AND DYKE, C. G.: Osteoporosis Circumscripta of the Skull as a Form of Osteitis Deformans. *Am. J. Roentgenol.* 28: 192-203, August 1932.  
 MAHER: Beiträge zur pathologischen Anatomie einer Form der Schädelatrophie. *Virchows Arch. f. path. Anat.* 7: 336-340, 1853.  
 MOORE, SHERWOOD: Symmetrical Thinness of the Parietal Bones. *J. Missouri M. A.* 26: 396-397, August 1929.  
 PANCOAST, H. K., PENDERGRASS, E. P., AND SCHAEFFER, J. P.: *The Head and Neck in Roentgen Diagnosis*. Springfield, Ill., Charles C Thomas, 1910.  
 PATERSON, A. M., AND LOVEGROVE, F. T.: Symmetrical Perforations of the Parietal Bones: Including an Account of a Perforated and Distorted Cranium from the Liverpool Museum. *J. Anat.* 34: 228-237, January 1900.  
 PEPPER, O. H. P.: Discussion. *Am. J. Roentgenol.* 35: 8, January 1936.  
 PEPPER, O. H. P., AND PENDERGRASS, E. P.: Hereditary Occurrence of Enlarged Parietal Foramina; Their Diagnostic Importance. *Am. J. Roentgenol.* 35: 1-8, January 1936.  
 PIERSON, G. A.: *Human Anatomy*. Philadelphia. J. B. Lippincott Co., 7th ed., 1919.  
 REDLICH, E., AND SCHÜLLER, A.: Über Röntgenbefunde am Schädel von Epileptikern. *Fortschr. a. d. Geb. d. Röntgenstrahlen.* 14: 239-249, 1909-10.  
 ROKITANSKY, CARL: *Handbuch der speziellen pathologischen Anatomie*. Vienna, Braumüller & Seidel, 1844, vol. 2, p. 243.  
 SANTE, L. R.: *Principles of Roentgenological Interpretations*. Ann Arbor, Edwards Bros., Inc., 1937.  
 SCHMIDT, M. B.: Atrophie und Hypertrophie des Knochens einschliesslich des Osteosklerose. In Henke and Lubarsch: *Handbuch der speziellen pathologischen Anatomie und Histologie*. Berlin, Julius Springer, vol. 9, part 3, 1937, pp. 1-86.  
 SHEPHERD, F. J.: Symmetrical Depressions on the Exterior Surface of the Parietal Bones (with Notes of Three Cases). *J. Anat.* 27: 501-504, July 1893.  
 SMITH, G. E.: The Causation of the Symmetrical Thinning of the Parietal Bones in Ancient Egyptians. *J. Anat.* 41: 232-233, April 1907.  
 SOSMAN, M. C.: Discussion. *Am. J. Roentgenol.* 35: 8, January 1936.  
 VIRCHOW, RUDOLPH: Ueber die Involutionserkrankheit (Malum senile) der platten Knochen. *Verhandl. d. phys.-med. Gesellsch. in Würzburg* 4: 354, 1854.

# Roentgen Therapy of Pelvic Tuberculosis in the Female<sup>1</sup>

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IN REVIEWING the work that has been done in the roentgen therapy of pelvic tuberculosis in the female, one is impressed by the scant concern with it in this country, as compared with its wide utilization in continental Europe and the extensive literature arising therefrom. In the United States the effect of x-ray treatment on tuberculous granulation tissue in general, and on tuberculosis in other locations, such as lymph nodes, has received fair attention. As to tuberculosis of the female reproductive organs and pelvic peritoneum, a few writers have reported a few cases, but there have been no large series. Ford (1) lists 35 cases of abdominal and pelvic tuberculosis, of which 7 were in the female generative organs. Polak (2), reporting on subacute adnexal inflammations treated with x-rays (castration), states that 8 of the cases in his series were tuberculous. An article by Schmitz (3) emphasizes chiefly carbon-arc therapy, although x-ray irradiation is mentioned. Jameson (4) and Lenz and Corscaden (5) review the literature and report 2 and 3 cases, respectively. The predominance of German literature on the subject is illustrated by a long and comprehensive article by Bickenbach (6), at the end of which he lists 258 references exclusive of abstracts, of which all but twenty-two are German. The majority of the latter are French. To be sure, not all of these articles deal primarily with the x-ray treatment of pelvic tuberculosis. Some are on the more general subject of the handling of pelvic tuberculosis, operatively and otherwise, while some discuss the effect of x-rays on tuberculosis in general. Nevertheless, judging by this compendium

and other literature, the interest of German workers seems to have outweighed that of other countries ten to one.

In 1898 Ausset and Bédart (7) reported the successful treatment of a case of peritoneal tuberculosis which had proved resistant to other forms of therapy. In 1907 Bircher (8) reported 26 cases of tuberculous peritonitis improved or cured by x-ray. Spaeth (9), in 1911, cured a hopeless case of genital tuberculosis, and other reports appeared around that time. After this the method seems more or less to have fallen into disuse for ten years. According to Bickenbach, it has been "forgotten again and again," only to be rediscovered or revived in this or that clinic. The greatest interest, as judged by published articles, was shown in the years from 1921 to 1936. An incomplete but fairly extensive search of foreign irradiation literature from 1938 through 1941 shows not a single original article on the subject.

The effect of x-rays upon tuberculous granulation tissue has been considered extensively in both American and foreign literature and will not be dealt with here. Instead I shall attempt to assay the clinical advantages of x-ray therapy as against surgery or accompanying it, discussing briefly the experiences and technics of various workers and adding a few illustrative case reports.

The term genital tuberculosis in the female properly refers to tuberculosis of the vulva, vagina, uterus, ovaries, and tubes, but as disease of the pelvic peritoneum is such a frequent accompaniment, particularly of tubal involvement, it also will be included. Tuberculosis of the vulva, vagina, and cervical lip is rare, and involvement of the ovaries is also infrequent, being found but three times in a series of 94 cases of pelvic tuberculosis at the Woman's Hospital in New York. I have

<sup>1</sup> From the Woman's Hospital, New York, and the N. Y. Infirmary for Women and Children. Read in part before the New York Roentgen Society, May 17, 1943. Accepted for publication in August 1943.

found but one report of involvement of Bartholin's glands. Disease of the endometrium alone is unusual. Novak (10) states that almost without exception it is secondary to disease in the tubes and he considers that one is justified in assuming tubal involvement where curettage reveals endometrial tuberculosis. Conversely, Bickenbach says that the endometrium is found to be diseased in 50 to 70 per cent of cases of tubal involvement. The commonest types of the disease in the female pelvis are tuberculosis of the tubes and of the pelvic peritoneum, or a combination of the two. Jameson reports that over 90 per cent of the tubal cases are bilateral.

Schmitz states that 3 per cent of female cadavers show genital tuberculosis and that 10 per cent of chronic tubal inflammations are tuberculous. Lenz and Corscaden report that of 850 cases of chronic pelvic inflammatory disease examined microscopically in their institution, 41 were tuberculous salpingitis. An extremely low incidence is found at the Woman's Hospital where, in the years 1929 to 1942 inclusive, there were 27,160 gynecological admissions, and only 94 cases of pelvic tuberculosis.

#### SURGERY AND IRRADIATION

Only surgical and radiation therapy will be considered here. The surgical approach is in general of two types: conservative, removing only diseased tissue, and radical. Jameson states that the principal objection to conservative surgery is the impossibility of determining the extent of disease macroscopically. Other surgical procedures are aspiration of ascitic fluid and laparotomy for diagnosis and for the removal of fluid and pus. X-ray procedures include primary x-ray treatment, irradiation following conservative and radical surgery and surgical drainage, and irradiation of recurrences. Primary x-ray treatment I consider of limited value, as in the majority of cases some sort of surgical procedure will always remain obligatory for diagnosis. The irradiation treatment of undiagnosed pelvic conditions

on a supposition based on the presence of tuberculosis elsewhere seems completely unwarranted. Except for endometrial biopsy and the occasional opportunity for an external biopsy, as from a fistulous tract, there is no way to make an adequate diagnosis except by curettage or by exploratory laparotomy.

Once having determined the presence of the disease, what is the proper use of x-ray therapy and what is its value weighed against further surgery or combined with it? Gauss (11) and Gal (12) both believe that early, limited, circumscribed cases do equally well with surgery or irradiation, while late cases respond poorly to either. This is reasonable but obviously leaves the largest, intermediate group for further judgment and disposal. It will be shown below that clean, apparently successful operative removal may be followed by recurrence, for which x-ray therapy is often strikingly effective. Surgeons usually prefer to operate in the operable cases, from mental habit and because, even when aware of the successes of x-ray in the field, they consider surgery a shorter procedure for the patient than long-drawn-out multiple irradiation cycles. Against surgery is the operative mortality (7 to 8 per cent according to Lenz and Corscaden), the occurrence of postoperative fistulae, estimated at 5 to 10 per cent, the possible production of miliary tuberculosis, the danger of injury of the bladder and rectum during the operation, as the line of cleavage is sometimes hard to find, and the likelihood that structures left behind may already be invaded by tuberculous granulations. X-ray treatment has no effect on pyosalpinx, ascitic fluid, or abscess material. It should be absolutely avoided in pregnancy. In peritoneal tuberculosis it is most successful in the dry form with moderate plastic exudate, but it is also useful postoperatively after fluid and non-viable debris have been removed. Protection of the ovaries in the child-bearing period should be considered in deciding on the type of treatment and, if x-ray is used, in planning



the dosage, although some consider this unimportant on the ground that patients with pelvic tuberculosis are likely to be sterile or, contrarily, that pregnancy is undesirable for them. In cases of mixed infection, tuberculous and other types, the individual case must be considered on its merits, as a candidate for one or the other type of treatment.

When disease of the endometrium alone is diagnosed, by biopsy or curettage, and there are no symptoms referable to the tubes or peritoneum, it is probably best to try x-ray as a primary procedure, including the tubes in the treated field because of the probability of at least minimal disease there. When frankly diseased tubes are diagnosed at operation, their removal followed by irradiation is usually the method of choice. In advanced tubal-peritoneal disease the combined treatment is also preferred, with laparotomy for diagnosis and removal of fluid or necrotic tissue where present, followed by x-ray therapy. The worst prognosis is found in cases of severe disease elsewhere, either in a supposedly single focus or generalized, although these patients, if not too badly off, frequently benefit from palliative treatment of their pelvic symptoms.

#### CONSIDERATION OF RESULTS

Attempts to assess results from various clinics prove difficult because of the varying and often indefinite criteria for success, and indeed sometimes for diagnosis. Cases are reported "improved" or "cured" with lines between these results not clearly drawn. Bickenbach does not consider a patient cured until she has "lived a normal life for three years." But what is a normal life, in respect to genital tuberculosis? Döderlein (13) states that "actual cure in the anatomical and biological sense cannot be established in genital tuberculosis. All that can be done is to note subjective improvement, increase in bodily strength, etc." More solid ground is reached where a palpable mass actually disappears under x-ray treatment, or a series of endometrial biopsies shows improvement in a lesion.

TABLE I: RESULTS OF DIFFERENT TYPES OF TREATMENT  
(Summarized from Five Tables by Bickenbach)

Type of Treatment	Contributing Authors	Total Cases	Cured or Improved
Operation and post-operative x-ray therapy	9	158	106(67%)
X-ray therapy only	14	309	243(78.5%)
X-ray therapy following exploratory laparotomy (including removal of fluid)	7	150	120(80.5%)
Operation only (before 1912)	6	165	113(68.5%)
Operation only (1925-33)	4	128	76(59.5%)

Bickenbach warns that we should not attempt to compare surgical and x-ray treatment results unless we note the degree of disease and recommends the classification of cases for statistical purposes as localized, advanced, and hopeless. But such classification is too seldom available to influence greatly the comparison of results or any deductions as to treatment principles.

Among the largest of the x-ray series is that of Wesseling (14), consisting of 115 cases—65 adnexal, 35 adnexal and peritoneal combined, 15 in other locations—of which 66 were reported cured and 24 improved. Gragert (15) reported 44 cases, with 22 cured, 9 improved, 5 dead, and the remainder not followed. Out of a total of 79 cases, Gal irradiated 25, with 6 "healed," one up to twelve years, and 8 "apparently healed." Bickenbach collected from the literature the remarkable number of 910 cases of female pelvic tuberculosis, of which 617 were irradiated. Two hundred and ninety-three had surgical treatment only and are used for comparison. It seemed of some interest to summarize his totals as given in a group of five tables (Table I). These totals are gross figures, uncorrected for short periods of observation or death from other causes (both of which are included in the original tables). Since separation of "cured" and "improved" is made in some tables and not in others, I have combined the two columns for uniformity. The separate columns

may be found in the original text. These results offer a brilliant showing in favor of x-ray treatment but, as is so often the case in statistical presentations, there are unknown and qualifying factors which cannot be dug out in numbers commensurate with the statistics themselves.

### TECHNIC

The discussion of technic to follow refers exclusively to x-rays, though radium is sometimes used. Gal prefers radium in portio and endometrial tuberculosis, and x-rays in the adnexal-peritoneal combination. I have had no experience with radium. For x-ray technic, dosages recommended by various workers run all the way from the old "tuberculosis dose" of Seitz and Wintz, of 50 per cent (or 54 per cent) effective in the tissues, to the 5 per cent E.D. which, according to Bickenbach, Seitz later gave. Bickenbach himself gives a 35 to 100 r tissue dose, with number of doses and time interval varied according to the needs of the patient. He recommends larger doses to produce freedom from pain quickly, and in fistulae, if there is no question of saving the ovaries, a 200 to 300 r tissue dose. Lenz and Corscaden recommend 75 r to an anterior abdominal field, adding a posterior field if the patient is fat. Their total dose varies but may run up to 750 r on the skin of the anterior abdominal wall over a period of ten weeks. An average dose for numerous workers seems to be 10 to 15 per cent E.D., repeated weekly two to four times, and with several cycles at monthly or longer intervals.

Gauss has an elaborate system of 120 r (air) for the first dose, 100 r for the second, 80 r for the third, 60 r for the fourth, 40 r for the fifth, with a six-week interval between doses. This sounds like an extreme degree of attenuation at the end, particularly in view of the six-week intervals, but as he uses a  $24 \times 20$ -cm. field his initial dose is fairly high. Wesseling employs an abdominal and a sacral port, each  $24 \times 24$  cm., obviously including much more than the pelvis itself. Martius (16) uses a very

large anterior field, giving 150 r at a dose, with a total of three doses at intervals of eight days. These large portals are common, and should be thought of when comparison is made with technics where smaller portals are used. It is difficult to understand the popularity of these huge portals except in widespread peritonitis. They would not be applicable to such lesions as the small recurrent masses described below, and the entire uterus and adnexa may readily be irradiated through a field  $16 \times 12$  cm. or less. Even in peritonitis, I prefer dividing the abdomen into smaller fields. It is more trouble, but gives a more uniform central ray dosage and seems to produce less nausea and intestinal gas than when the whole abdomen is rayed at once.

My dosage technic has changed somewhat over a period of years. Cases 2 and 10, treated about ten years ago, received 300 r in air at a dose, whereas more recent cases were given 75 to 100 r, following the general trend toward smaller doses, though some of my larger doses were successful. Treatments over the same field are not repeated oftener than once a week; treatment to different fields may be given two or three times a week if the portals are small. Possible variations in time spacing are illustrated in the cases reported below.

### CASE MATERIAL

A résumé of my 11 cases is given in Table II. It is notable that every case showed more than one focus of disease. Cases 10 and 11 appeared at first to be confined to the peritoneum, but in Case 10 there was a recurrent mass, and in Case 11 a second operation showed widespread disease of tubes and endometrium. This multiplicity of foci in the pelvis is common. There were 4 cases of pelvic peritonitis. It is recognized that the mere opening of the abdomen in this condition may be beneficial or even curative, but this seems less likely where other organs are involved. The most interesting results in the group are in the 6 cases with pelvic masses, 3 recurring after radical surgery and all 6 disappearing completely after irradiation.

TABLE II.: RESULTS OF ROENTGEN THERAPY IN ELEVEN CASES OF PELVIC TUBERCULOSIS

Case	Location of Disease	Method of Diagnosis	Other Foci of Disease	Results	Followed After Irradiation
1. E. F.	1. Endometrium 2. Mass in rectovaginal septum	1. Endometrial biopsies 2. Palpation	Lungs and bone, healed	Clinically free of disease Mass disappeared	1½ yr.
2. J. A.	1. Both tubes 2. Endometrium 3. Recurrent mass after operation	1. Laparotomy 2. Curettage 3. Palpation	None found	Clinically free of disease. Mass disappeared	2½ yr.
3. F. A.	1. Both tubes (removed at operation) 2. Recurrent masses after operation	1. Laparotomy 2. Palpation	None found	Clinically free of disease. Mass disappeared	2½ yr.
4. D. R.	1. Endometrium 2. Mass in right pelvis (tube?)	1. Curettage 2. Palpation	None found	Clinically free of disease. Mass disappeared	2 yr.
5. D. E.	1. Endometrium 2. Bilateral pelvic masses (tubes?)	1. Curettage 2. Palpation	Lungs clear. History suggestive of peritonitis or salpingitis ten years before	Clinically free of disease. Masses disappeared	1 yr.
6. H. O.	1. Endometrium 2. Abscess opening into vagina (probably tuberculous salpingitis)	1. Curettage 2. Inspection	None found	Improved. General health good. Pelvic thickening remains	3 yr.
7. P. O.	1. Sinus draining into vagina (right) 2. Pelvic mass (left), assumed to be bilateral salpingitis	1. Biopsy 2. Palpation	None found	Slight improvement, but returned to surgeon for drainage, etc. (age 17)	4 mo.
8. K. E.	1. Peritoneum 2. Small intestine (moderate ascites)	1 and 2. Laparotomy and biopsy 2. Barium enema	Calcification in lungs	Striking improvement, but disappeared from follow-up	4 mo.
9. N. I.	1. Both tubes 2. Peritoneum	1 and 2. Laparotomy and biopsy	Lungs negative 6 months before treatment; 2 months after treatment bilateral pulmonary disease	Pelvic symptoms gone, masses almost gone at 2 months. Died from chest condition	6 mo.
10. A. L.	1. Peritoneum 2. Recurrent mass in rectovaginal septum	1. Laparotomy and biopsy 2. Palpation	Calcified scars in lungs	Clinically free of disease. Mass disappeared	3 yr.
11. F. O.	1. Peritoneum 2. Cervix 3. Endometrium and tubes (2 and 3 found 1½ years after 1)	1. Laparotomy 2. Biopsy 3. Laparotomy	Scars in lungs	Clinically free of disease 1½ years, when new lesions were found	1½ yr.

Four cases were symptomatically improved, but for various reasons were unsatisfactory in the end. One patient showed little improvement.

CASE I: E. F., age 39, had been at Saranac twelve years before admission, with tuberculosis of the lungs, one wrist, and the left sacroiliac joint. All the lesions had healed, the sacroiliac joint following fusion. On examination in the Woman's Hospital sterility clinic, the uterus was found normal in size, the adnexa normal. A small, hard, non-tender

mass was present in the rectovaginal septum. Endometrial biopsy showed tuberculosis (Fig. 1A).

The patient was referred for x-ray therapy and received four weekly treatments of 150 r each (air), anterior and posterior fields measuring 10 × 16 cm. being treated alternately. A month after the last treatment the mass was 50 per cent smaller, the patient was gaining weight and having hot flashes, and a second endometrial biopsy was reported as "tuberculous endometritis, chronic, in a stage of fibrosis." A duplicate x-ray cycle was given three months after the first, and a month later a third

biopsy (Fig. 1B) was reported as "organized, scarred tuberculous granulation tissue." There was slight thickening in the rectovaginal septum. Four months later this had completely disappeared and the patient weighed 134 pounds, a gain of 12 pounds. No further biopsies were done, but the tuberculous process seems obviously to have been halted by the radiation, as evidenced by disappearance of the mass, gain in weight, and maintenance of good health for as long as the patient was followed, a period of one and a half years after the last treatment.

pelvic port 12 X 12 cm., and a week later the same dose through a right posterior port. A month after this the mass was smaller and the pain less, but at a second monthly visit the mass was larger and there was more pain. A second cycle of two treatments was given, with the same dosage as before. The result duplicated that following the first cycle, with improvement in the first month, not maintained during the second. After a third x-ray cycle the mass diminished slowly, disappearing completely after four months. The patient had no further symptoms during the two and a half years

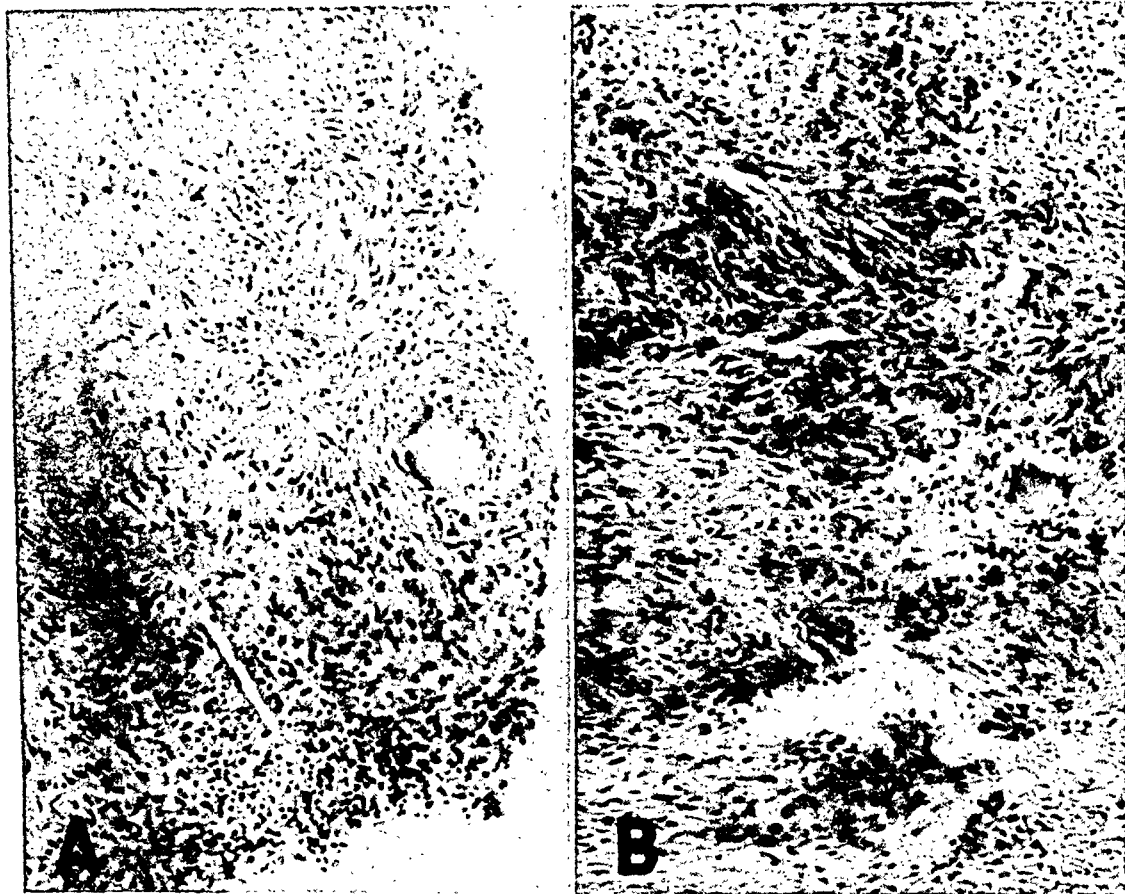


Fig. 1. Case 1: A. Endometrial biopsy made before x-ray treatment. B. Biopsy specimen one month after second x-ray cycle, four months after first cycle.

CASE 2: H. J. was admitted complaining chiefly of bleeding. A diagnosis of pelvic inflammatory disease was made. Operation showed chronic inflammation of both tubes, a cyst of the left broad ligament, and all pelvic structures encased in veil-like adhesions. The procedures were preliminary curettage, bilateral salpingectomy, left oophorectomy, and removal of parovarian cyst. Pathological report: tuberculosis of the endometrium and both tubes. Recovery was uneventful, but two months later the patient returned to the clinic with severe pain in the right pelvis, where a mass 3 in. in diameter was found. She received 300 r in air to a right anterior

she was followed. Here it took three rounds of x-ray at intervals of two months to effect permanent resolution of the mass and permanent cure of pain. The patient menstruated throughout the period of observation.

CASE 10: A. L., a Puerto-Rican woman of 50, was admitted to the Woman's Hospital for abdominal pain and distention. Operation showed thickened omentum and an extreme degree of adhesions involving it and multiple intestinal coils. The appearance suggested generalized carcinomatosis, and the abdomen was closed. The pathological report was tuberculosis.

The patient did poorly postoperatively. Pain, fever, and distention persisted and even increased. X-ray therapy was then instituted. The entire abdomen was divided into four anterior and four posterior fields and one field was treated every two to three days, each receiving 300 r, once around. Three weeks later a duplicate cycle was given. Two months after the second series of treatments the abdomen and pelvis were soft; some pelvic tenderness could be elicited, but no pain, and even the tenderness disappeared by the next visit. There were no further symptoms for six months, when the patient returned complaining of weakness and anorexia, abdominal and lumbar pain, and loss of weight. A soft, tender mass the size of a lime was found between the cervix and rectum. Two more cycles of x-ray, identical in pattern with the preceding except that the upper half of the abdomen was omitted, were given two months apart. Distention and weakness gradually diminished. The recurrent mass had disappeared four months after treatment, the abdomen was soft, there was no pain or tenderness, and there had been an appreciable gain in weight. The patient was followed for over three years from the last x-ray treatment, during which time there was no evidence of recurrence and she remained in good health.

Failure or partial failure is often more instructive than success and, with this in mind, a second case of pelvic peritonitis is reported, providing a comparison with Case 10 as to handling and outcome.

CASE 11: F. O. entered the Woman's Hospital because of a pelvic tumor. At operation the uterus was found to be converted into an irregular mass of fibroids the size of a four months' pregnancy. The entire visceral and parietal peritoneum was covered with innumerable yellowish-white nodules ranging in size from a pin point to a pea. Large and small intestine were densely adherent to each other and to the pelvic organs and similarly covered with nodules. The right adnexa were converted into a cystic mass the size of a lemon but not clearly seen because of adhesions. The left tube was covered with nodules, but the left ovary was normal in appearance. A frozen section was diagnosed as carcinoma and the abdomen was closed. The subsequent pathological report was chronic tuberculosis of the peritoneum with beginning caseation.

Two weeks later the patient was referred for x-ray therapy. The lower abdomen was divided into four fields, two anterior and two posterior, 10 X 16 cm. Each field received 200 r (air) at a dose, two fields a week being treated, going three times around, so that 12 treatments, and 600 r per field, were given over a period of six weeks. Pain and tenderness subsided rapidly and were almost gone at the end of the x-ray treatment. Six months later the only abnormality remaining was the fibroid. The patient

had not menstruated since one month after treatment. She felt so well she had taken a job as a presser. Six months later she was still feeling well and was employed at the same job. One and a half years after treatment she had no complaints, but a small, eroded, nodular area was discovered on the cervix. A biopsy showed tuberculosis. As the fibroid also seemed larger, it was decided to do a hysterectomy. At the second operation large, multiple, pedunculated and intramural fibroids were found. There were numerous small white nodules on the peritoneal surfaces of the small bowel, but the widespread peritoneal disease seen at the first operation was not present. A complete hysterectomy and bilateral salpingectomy were done. The microscopic pathological report was: "scattered tubercles in endometrium, none in myometrium. Cervical mucosa obliterated in part and replaced by compact masses of tuberculous tissue. Both tubes contain densely aggregated masses of tubercles, some of them having undergone caseation and necrosis. Nothing but fibrosis found in ovaries." Sections of peritoneum showed scarring of old disease, presumably post-irradiation.

This case raises interesting questions impossible to answer. I feel that the patient should have had one or two more cycles of x-ray therapy, but it is doubtful if that alone would have controlled the disease, because of the strain of her employment. After the first cycle she stayed at home for a while, but then felt so well that she took a job, the nature of which was not known at the clinic at the time. It seems amazing that she remained free of symptoms for a year and a half, as long hours on one's feet ironing in an over-heated room is certainly not regulation convalescent treatment for tuberculosis. In spite of this, the lesions found at the second operation were not so extensive as at the first, indicating considerable benefit from irradiation. The present plan is for the patient to receive more x-ray treatment, a longer rest period, and if possible less taxing work later.

#### SUMMARY

The status of irradiation treatment of pelvic tuberculosis in the female is discussed, in itself and in relation to and in comparison with surgical procedures. Techniques of various workers are described. Case reports illustrating treatment of different types and stages of the disease

are given. The frequency of multiple foci is pointed out. The favorable results in a small group of 11 cases are related, with 6 patients clinically free of disease one to three years and 4 more showing local improvement, though considered unsuccessful for various reasons.

X-ray therapy is recommended in adequately diagnosed cases of pelvic tuberculosis. Grossly diseased tubes should be removed if possible and the pelvis then irradiated to affect residual tuberculous granulations. Disease of the endometrium with minimal or no lesions in the tubes offers a good chance of success with irradiation alone. In peritonitis, x-rays are most useful in the dry form; they are useless against ascites and marked breaking down of tissue, but may be employed after these conditions have been dealt with surgically. Irradiation seems particularly effective in localized recurrences following surgery.

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#### REFERENCES

1. FORD, F. A.: Roentgen-Ray Treatment of Abdominal and Pelvic Tuberculosis. *Minnesota Med.* 10: 32-37, January 1927.
2. POLAK, J. O.: A Preliminary Report on Temporary Roentgen-Ray Castration in the Treatment of Subacute Adnexal Inflammation. *Am. J. Obst. & Gynec.* 18: 580-586, October 1929.

3. SCHMITZ, HENRY: Treatment of Tuberculosis of the Female Genitalia with Light and X-Rays. *Radiology* 4: 283-287, April 1925.
4. JAMESON, E. M.: Tuberculosis of Uterus and Fallopian Tubes with Report of Two Cases Treated with X-Rays. *Am. J. Obst. & Gynec.* 27: 173-184, February 1934.
5. LENZ, M., AND CORSCADEN, J. A.: X-ray Therapy of Tuberculosis of Female Reproductive Organs. *Am. J. Surg.* 33: 518-522, September 1936.
6. BICKENBACH, W.: Die Strahlenbehandlung der weiblichen Genitaltuberkulose, in *Ergebnisse der medizinischen Strahlenforschung*, edited by Holfelder *et al.*, Vol. 7, 1936, pp. 290-340.
7. AUSSET AND BÉDART: Péritonite chronique tuberculeuse traitée successivement et sans résultat par les moyens habituels; radiothérapie; guérison consécutive. *Bull. Soc. centr. méd. du nord, Lille* 2: 270-287, 1898.
8. BIRCHER, E.: Die chronische Bauchfelltuberkulose und ihre Behandlung mit Röntgenstrahlen. Aarau, 1907. Quoted by Bickenbach.
9. SPARTH, Ein Fall von Genitaltuberkulose geheilt durch Röntgenstrahlen. Quoted by Bickenbach.
10. NOVAK, E.: *Gynecological and Obstetrical Pathology*. Philadelphia, W. B. Saunders Co., 1941.
11. GAUSS, C. J.: Unsere Röntgentherapie der weiblichen Genito-Peritonealtuberkulose. *Strahlentherapie* 51: 371-381, 1934.
12. GAL, F.: Diagnostik und Therapie der weiblichen Genitaltuberkulose. *Strahlentherapie* 59: 513-525, 1937.
13. DÖDERLEIN, G.: Entstehung, Erscheinung, und Behandlung der weiblichen Genitaltuberkulose. *Beitr. z. Klin. d. Tuberk.* 63: 672-683, 1926.
14. WESSELING, M.: Die Röntgenbehandlung der Genitaltuberkulose der Freiburger Frauenklinik. *Strahlentherapie* 24: 459-464, 1927.
15. GRAGERT, O.: Über Genital und Bauchfell-tuberkulose beim Weibe. *Strahlentherapie* 23: 495-603, 1926.
16. MARTIUS, H.: Die Strahlenbehandlung der weiblichen Tuberkulose. *Strahlentherapie* 21: 260-265, 1926.



# Giant-Cell Tumor of the Lower Femur

Case Report with Roentgen and Pathological Findings Before and After Curettage and Roentgen Therapy with Amputation for Sarcoma<sup>1</sup>

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FOR 125 YEARS, from 1818 to 1943, low-grade neoplastic processes, now generally designated "giant-cell tumors of bone," have been mentioned in the medical literature. Cooper and Travers (20) seem to have described them well grossly, with some clinical and therapeutic aspects, in 1818. Lebert (45) is usually given credit for the first description of the giant cells of the medullary tumors in 1845. In 1854, Paget (56) referred to many cases of "myeloid tumor" and discussed in detail the gross, microscopic, clinical, and operative details. He believed these tumors were "not apt to recur after complete removal." In 1860, Nélaton (54) reported 46 cases in detail, and in 1879 Gross (32) followed with 70 cases of benign giant-cell sarcoma, 5 of which underwent malignant change. Virchow (69) in 1865 raised the question of malignant behavior of myeloid sarcomas. Although most of the cases appeared to be benign, excision or amputation was considered the safe therapeutic procedure for nearly one hundred years. Bloodgood (4) watched Halsted excise the lower forearm and carpal bones for a giant-cell sarcoma in 1893 and performed his own first curettage of the tibia in 1902. Coley (15) in the same year began x-ray therapy in conjunction with surgery and the use of toxins for bone sarcomas. Pfahler (58), in 1906, made roentgenograms and gave roentgen therapy alone to a giant-cell tumor of the upper fibula. Mallory (48), in 1911, and Bloodgood (5), in 1912, appear to be responsible for the change in nomenclature from "giant-cell sarcoma" to "giant-cell tumor."

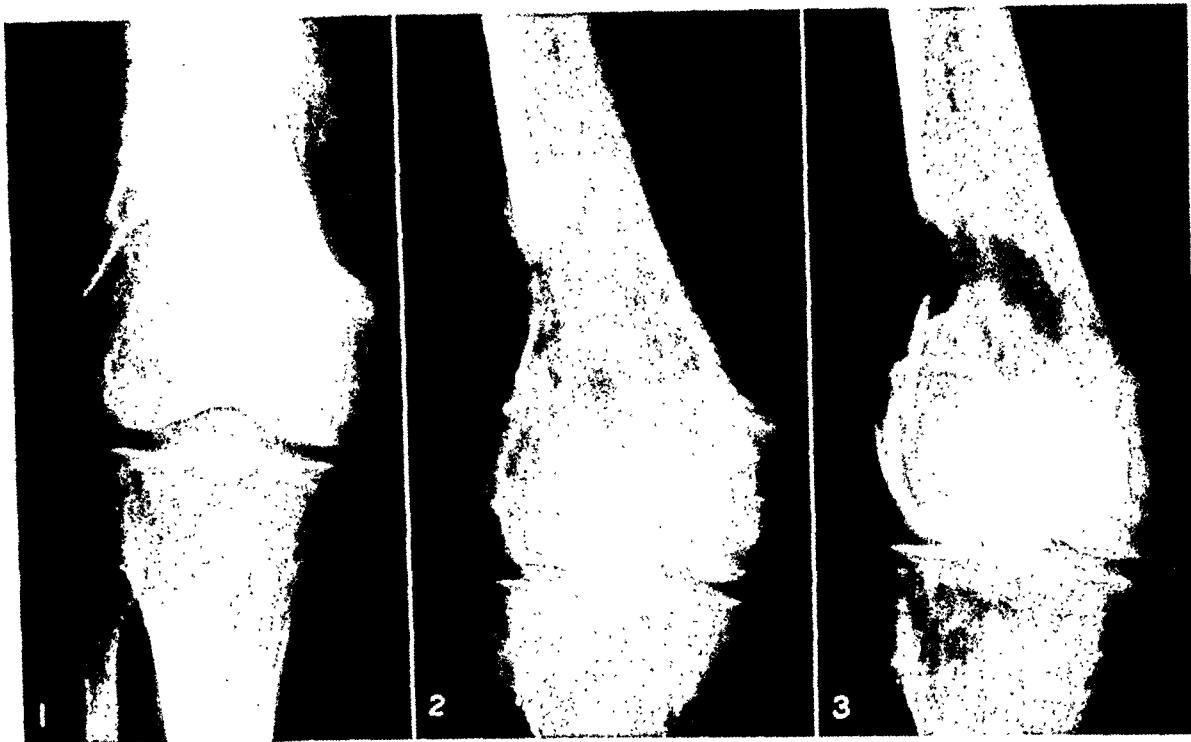
Favorable mention of roentgen therapy for giant-cell tumor has been made by

Pfahler (58), Coley (18), Bloodgood (6), Herendeen (34-36), Kolodony (44), Borak (7), Codman (11-13), Geschickter and Copeland (27-29), Brunschwig (8), Peirce (57), Evans and Leucutia (23), Ewing (24), Meyerding (51), Coley and Miller (14). The quantity and quality of radiation in the earlier years could not be accurately measured. Even in later years dosage has seldom been mentioned. When recorded, it has varied from a fraction of an erythema dose at intervals up to "eight treatments totaling 30,000 r (14,000 r laterally and 16,000 r medially)." This latter dose was given by Coley and Miller (14) to a tumor of the femur (factors: 250 kv., 1.5 mm. copper filtration, 50 cm. target-skin distance; lateral portal 8 × 12 cm., medial, 15 × 12 cm.) Successful dosage of tumors with adequate biopsy (not aspiration), followed for sufficiently long periods of time, has not been found in the medical literature. Sosman (63), Doub, Hartman and Mitchell (21), and Kleinberg (43) have had the courage to report poor results with roentgen therapy.

Curettage, instead of amputation or excision, was considered a possible method of treatment by the earlier surgeons, but it remained for Bloodgood (4-6) to advocate and popularize this type of therapy. Geschickter and Copeland (28, 29), his pupils, however, admit that primary curettement in 105 cases was followed in 31 by recurrence, with 16 cures on the second or third trial. Meyerding (51) appears to have used "excision by curettage" with success.

The age of our patient (50 years), the site in the lower femur, and the poor bony shell would be considered as contraindications to curettage by many surgeons.

<sup>1</sup> Accepted for publication in May 1943.



Figs. 1-3. Successive roentgenograms, Jan. 3, March 3, and Sept. 3, 1935. Figure 1, Jan. 3, 1935, led to a diagnosis of giant-cell tumor of the lower femur. Figure 2, March 3, was made about seven weeks following curettage and 1,000 r (measured in air) of medium-voltage roentgen therapy. Figure 3, Sept. 3, shows the remarkable improvement following 2,750 r (in air) of medium and deep roentgen therapy.

Hinds (37) and Bloodgood (5) both report cases at this site, successfully cured by curettement.

#### CASE REPORT

M. T. R., white married male aged 50 years, a farmer, was admitted to the hospital Jan. 3, 1935. His chief complaint was pain and swelling in the right knee, of two months' duration. Six months before admission his lower right thigh "gave way" while he was at work. Swelling began in the knee four months later and pain, aching in character, gradually increased in severity. The knee was slightly flexed and could not be fully extended, and the patient walked with the aid of crutches. No redness or heat had been noticed and there was no history of trauma. The past and family histories were irrelevant.

Physical examination was negative except for the right lower extremity. There were moderate swelling in the right knee and slight swelling in the right leg, ankle, and foot. The leg presented a bluish color with some pitting and edema of the ankle and foot. There was moderate tenderness over the entire knee joint, more pronounced over the outer side of the lower end of the femur. No sensory changes were observed. The dorsalis pedis pulse was felt, with no pulsation in the posterior tibial artery. The reflexes were normal.

The blood Wassermann test was negative. Urine examination was negative. The hemoglobin was 90 per cent, red blood cell count 4,120,000, white cell count 7,000 per cu. mm., with 84 per cent polymorphonuclears and 16 per cent lymphocytes. The blood sugar was 99, N.P.N. 34, calcium 12.7, phosphorus 3.6, chlorides 424 mg. per 100 c.c.

On Jan. 3, 1935, roentgen examination (Fig. 1) showed a large, rarefied, moderately trabeculated area in the lower right femur, measuring 7.5 cm. in length, 6 cm. in depth, and 9 cm. in width, apparently a large giant-cell tumor involving the medulla and cortex. The periosteum was not elevated. The cortex was not broken. There was slight decalcification of the bones of the knee, probably atrophy of disuse.

A film of the chest showed the lung fields to be clear and there was no evidence of any metastatic malignant process. Films of the skull and dorsal and lumbar spine, made on Jan. 5, showed no definite decalcification or miliary granular defects characteristic of hyperparathyroidism.

Operation by Doctor Griffin, Jan. 12, 1935, under ether anesthesia, disclosed a large cystic area in the external condyle of the femur, chiefly filled with friable material resembling granulation tissue but more yellow. Curettage of the cavity was performed, without note of any cauterization.

The gross pathological description was as follows: "Several pieces of tissue varying between 1 and 3



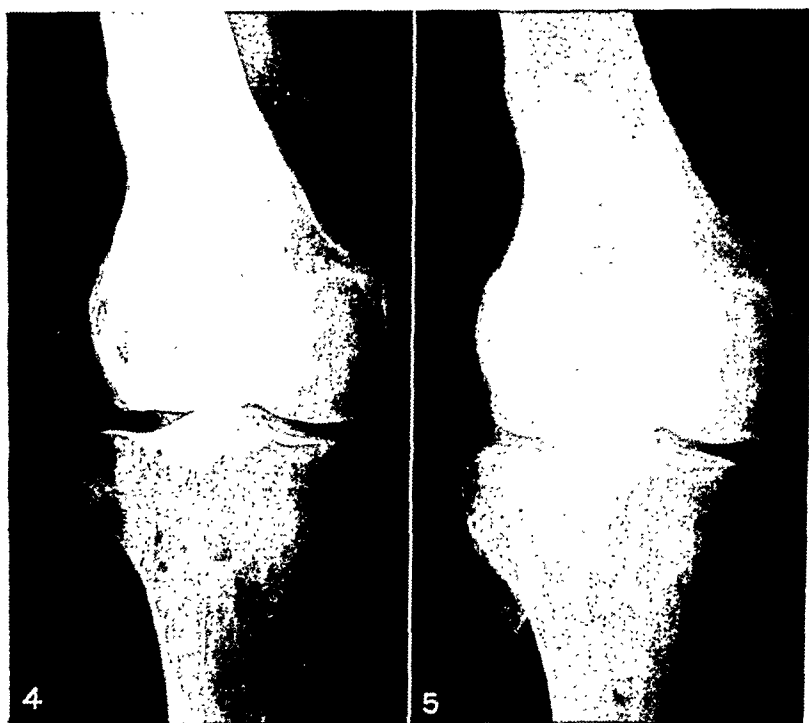
cm. in greatest dimension, comprising a bulk of approximately 15 c.c. They are irregular in shape, soft and friable in consistency; portions are red, other portions are pink, while much of the substance is yellowish-white and caseous in consistency."

Microscopic examination (Fig. 6) showed a granulation tissue-like matrix of fusiform, round, and polyhedral cells supporting numerous giant cells, constituting the essential structure of the tumor. There were, however, many areas of xanthomatous degeneration in which lipin-distended phagocytes predominated, without giant cells, and

showed slight bone productive change with very slight improvement. On Sept. 3, 1935 (Fig. 3), six months later, bone production had increased along all borders.

Clinically, the patient fared well for two and a half years. Pain then reappeared and he was admitted to the hospital on Sept. 26, 1937. Roentgenograms (Fig. 4) showed several cystic areas in the lower femur with surrounding bone production with thickened cortex. Roentgen therapy—1,700 r in air, 200 kv. with 2 Cu + 1 Al—was given in divided doses through anterior and posterior portals.

Following treatment the pain in the knee was en-



Figs. 4 and 5. Roentgenograms made in 1937 and 1938. Figure 4, September 1937, shows beginning thinning and rarefaction of the inner cortex, two years and eight months following curettage and the roentgen therapy mentioned in the legend of Figure 3. Figure 5, March 3, 1938, shows destruction of the inner cortex with tumor breaking through the soft tissues, two months following 1,700 r (in air) additional deep therapy.

also areas of sparsely cellular fibrosis, without giant cells.

The *pathological diagnosis* was: "benign giant cell tumor; radiosensitivity doubtful and unreliable; reported results inconsistent" (Lewis C. Pusich).

Two weeks after operation, in a ten-day period, 1,000 r measured in air (tumor dose of 500 r) was delivered to the lower right femur, using 130 kv. with 4 mm. Al, through anterior and posterior portals. The patient was discharged on Feb. 6.

Additional x-ray therapy was administered once monthly in March, April, May, June, and September, in 1935, with the above factors, in doses of 250 to 500 r, totaling 2,750 r in air.

Roentgenograms made March 3, 1935 (Fig. 2)

tirely relieved for about two months. Again an intermittent shooting pain confined to the inner side of the right lower femur appeared. Soft tissue swelling was found on physical examination.

On March 3, 1938, roentgen examination (Fig. 5) of the right knee showed the same dense trabeculated bone throughout the lower 4 inches of the femur. The outer four-fifths appeared solid. Just above the inner condyle was an area, 1 inch in diameter, which showed rarefaction, suggesting bone destruction. An area of density extended outward in the soft tissue past the cortex. The diagnosis was still giant-cell tumor.

On March 5, 1938, with a long 17-gauge needle an aspiration of the softened area on the media,

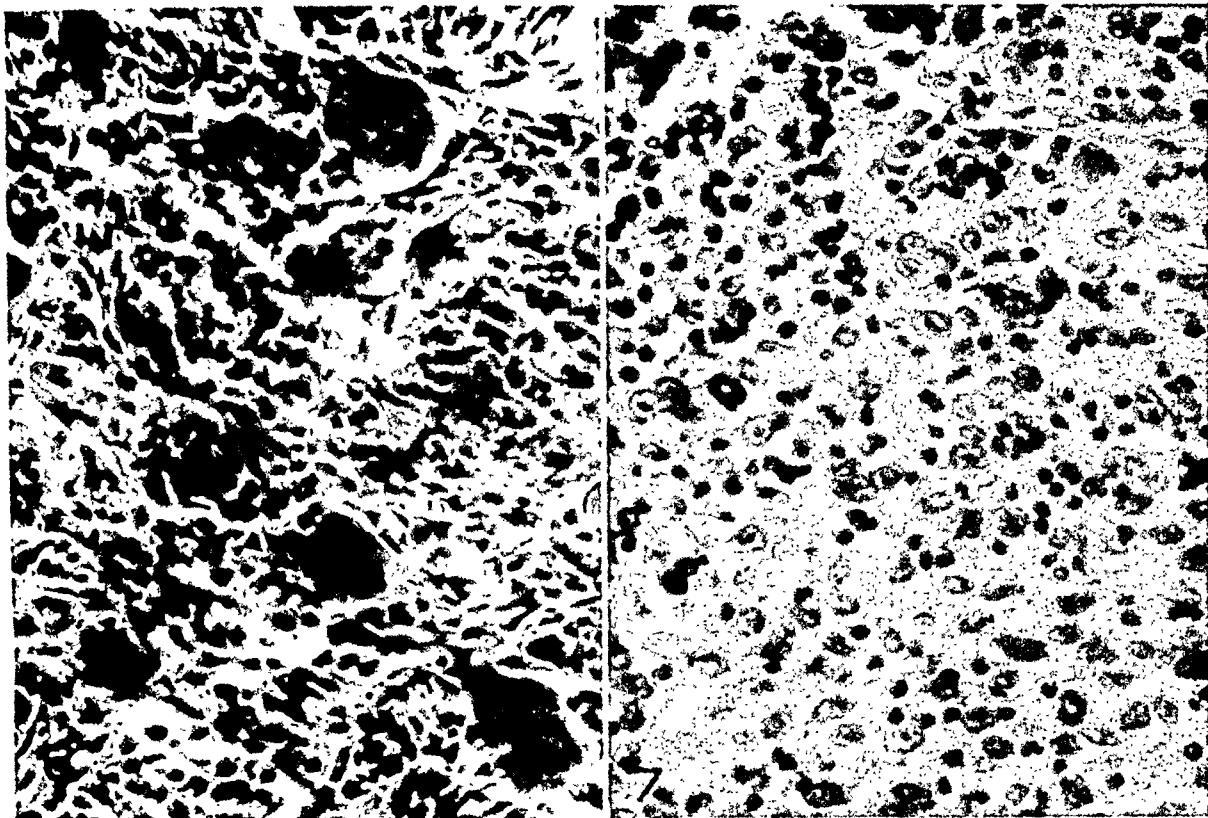


Fig. 6 Section (January 1935) showing typical structure of benign giant-cell tumor with uniform multinucleated giant cells, well differentiated. Fig. 7. Section (March 1938) of pleomorphic sarcoma showing large cells with hyperchromatic nuclei, prominent nucleoli, numerous mitotic figures, and atypical tumor giant cells. The tumor is infiltrated with small round cells resembling lymphocytes.

aspect of the lower end of the femur was done. In introducing the needle no resistance of the type produced by hard, firm, infiltrating tissue was encountered. The needle passed very easily, after traversing the subcutaneous tissue, into and through the mass and into the medullary spaces of the lower end of the femur. Occasional grating spicules of bone were encountered but the point of the needle did not come in contact with hard firm tissue which would be expected from a solid malignant growth.

The smear of aspirated material, stained with hematoxylin-eosin, showed the presence of small clumps of spindle-shaped cells of uniform size. They were not particularly hyperchromatic and appeared to be connective-tissue fibrocytes and osteoblasts. An occasional small osteoclastic giant cell was seen and small clumps of pseudoxanthomatous cells with granular abundant cytoplasm were found. No cytological characteristics indicating malignant change were observed. Other portions of cell clumps and tissue bits showed a loose connective-tissue type of stroma with abundant vessels.

The *pathological diagnosis* was: "benign giant-cell tumor of bone with abundant loose connective-tissue stroma and xanthomatous changes; no malignant changes found in aspirated material" (G. Z. Williams).

On March 14, 1938, curettage of the lower right femur was done under spinal anesthesia by Doctor Lippert and a cast was applied. The specimen included numerous soft gray and pink pieces of tissue, which, collected into a single mass, occupied a space approximately  $3.5 \times 2.5$  cm. Some of the larger pieces were moderately firm and gristle-like in consistency, measuring  $3 \times 2 \times 1$  cm. A separate larger specimen, soft and yellowish in color, measured  $4 \times 3 \times 1.5$  cm. and contained a few small spicules of bone. There were two other similar pieces,  $3 \times 2 \times 1$  cm., and a small piece of irregular bony tissue,  $2 \times 1 \times 1$  cm.

Of numerous sections of the curetted tissue, only two showed dense connective tissue and one showed normal tendinous tissue. These were taken from portions which appeared to be the wall of the soft tumor, where the bone tumor encroached upon the soft tissues after breaking through the cortex. The remainder of the sections, from the inner portion of the cyst-like cavity of the bone, were composed of masses of necrotic cellular tissue which appeared to consist of necrotic tumor cells. Scattered in the peripheral zone and in small groups through this necrotic material were portions of well preserved tumor cells. These were characterized by extreme pleomorphic variation in size, shape, and nature

(Fig. 7). They were markedly hyperchromatic, the nuclei and nucleoli were large and varied in size and shape, most of them being spindle-shape. Mitotic figures were abnormal, bizarre, and numerous. The picture was definitely that of a highly malignant sarcoma. There were also patches of xanthomatous cells in loose stroma. The tumor was vascular. The necrotic areas were greatly predominant.

The *pathological diagnosis* was: "pleomorphic-cell sarcoma of the femur" (G. Z. Williams).

On March 18, 1938, under spinal anesthesia, a mid-thigh amputation of the right femur was done (Fig. 8), with tourniquet (by Doctor Oden). The stump was covered with equal skin flaps and the sciatic nerve was injected with alcohol. On March 31 the wound was healed and the patient was discharged the following day.

The patient was requested to return for examination at six-month intervals. He was living and well in March 1943, five years after amputation for sarcoma. Roentgenograms of the chest and physical examinations never disclosed any evidence of recurrence or metastases.

#### DISCUSSION

We realize that there are skeptics who will refuse to accept the evidence as presented in the reports and illustrations (Figs. 1 to 8), or even in the originals. They will refuse to be convinced unless the patient dies from ultimate metastasis. The microscopic diagnoses of benign giant-cell tumor and later pleomorphic sarcoma were reviewed by several competent and experienced pathologists with no differences of opinion. The sections were adequate and obtained from abundant curetted material in both instances. The patient has survived the amputation without recurrence or metastases more than five years. Roentgenograms demonstrated growth at the tumor site for six months preceding amputation. Roentgen therapy preceded a delayed amputation. Both of these procedures have been widely advocated in the treatment of bone sarcoma, and several patients are known to have survived.

Malignant change, with or without metastases, in cases originally considered to be giant-cell tumors, has been mentioned and discussed by Augé and Roux (2), Brunschwig (8), Chatterton and Flagstad (9), Codman (13), Coley and Miller

(14), Coley (18, 19), Doub, Hartman and Mitchell (21), Dyke (22), Finch and Gleave (26), Goforth (30), Greenough, Simmons and Harmer (31), Gross (32), Jaffe, Lichtenstein and Portis (39), Kleinberg (43), Lewis (46), MacGuire and McWhorter (47), Morton and Duffy (52), Nélaton (54), Orr (55), Simmons (61), Stewart, Coley and Farrow (64), Stewart (65), Stone and Ewing (67), Turner and Waugh (68), Virchow (69), and others. In spite of the voluminous literature, a careful search will disclose very few case reports which can withstand the devastating critical analyses and rigid standards of the skeptics mentioned at the beginning of this discussion.

Geschickter and Copeland (28), following Bloodgood, have been the chief proponents of the benignancy of all giant-cell tumors. In 1930 they stated, in a review of 222 cases of giant-cell tumor, that "in no case has transformation of giant-cell tumor into sarcoma been proved." In 1936 (29) they modified this statement as follows: "The question is not whether a giant-cell tumor will metastasize—it never does—but whether these growths when they recur after improper treatment will undergo malignant change and give rise to osteogenic sarcoma. This question must now be answered in the affirmative." However, they stress the absence of reports in which metastatic nodules have shown the structure of typical giant-cell tumors. When osteogenic sarcoma of bone develops, they believe that "the unhealed area of bone and not the nature of the original lesion is the important factor."

This seems to us to be an evasion of the main point of the argument on a technicality, *i.e.*, that when sarcoma has developed the histologic picture is no longer that of giant-cell tumor. Even if this be granted, for lack of evidence to the contrary, it does not alter the fact that, under present methods of treatment, a definite percentage of giant-cell tumors (7 to 15 per cent) pursue a course which must be regarded as malignant. That the cell type and

histologic picture of the tumor may change markedly in this process does not seem too surprising. Unless it can be shown conclusively that proper treatment can eliminate this percentage of malignant changes, it seems only logical to regard this as part of the natural history of the tumor.

We will readily agree that the most satisfactory evidence of the malignancy of a tumor is microscopic proof of metastasis. On the other hand, it seems to be carrying skepticism too far to refuse to call a tumor malignant unless metastasis occurs in spite of treatment. If this were the standard for other tumors, the percentage of cures would drop to zero.

Jaffe, Lichtenstein and Portis (39) classify giant-cell tumors of bone into three grades of increasing invasiveness, according to the character of the stroma. In grade I, the stromal cells are uniform in appearance, abundant, and compact. In grade II, the stromal cells are not so compact and are often disposed in whorls; tumors of this order may recur and become malignant. Grade III tumors are frankly invasive and metastasize; the stroma is loosely arranged, there is much pleomorphism of cells and mitotic figures are numerous. There is much to commend such a classification.

Before the recognition of hyperparathyroidism as a clinical entity (38), cases of multiple giant-cell tumors of bone were reported and Alexander and Crawford (1) summarized the literature up to 1927. A study of these cases from the clinical, pathologic, radiologic, and chemical aspects reveals that they were nearly all cases of hyperparathyroidism. Jaffe (38) deplores the tendency to label as a giant-cell tumor any fibrous lesion or scar in bone which contains a few osteoclasts. According to him, "strictly defined, a solitary giant-cell tumor of bone is a true neoplasm which originates from mesenchymal connective tissue and in which the stromal cells and the giant cells show a close histogenic relationship. Furthermore, in such a tumor, one should be able to see evidence that the giant cells



Fig. 8. Gross specimen (March 1938) of the amputated femur following curettement, showing cyst-like defect in inner aspect of the femur.

are abundant, are a significant part of the histologic picture, and do not resemble ordinary osteoclasts."

Therapeutically, there seems to be general agreement that the benign tumors are usually cured by thorough curettage or excision. Also it appears that amputation is agreed upon as the treatment of choice in the malignant tumors.

Where amputation is impossible, as in the spine or skull, and in surgically inaccessible benign tumors, roentgen irradiation is advocated by most of the conservative authors. Frankly, however, we cannot agree to such a broad therapeutic principle. We would advocate leaving alone a grade I benign giant-cell tumor inaccessible to curettage or excision rather than subject it to the as yet undetermined hazards of irradiation. In malignant tumors (grade II and grade III, Jaffe) inaccessible to excision or amputation, pro-

tracted roentgen irradiation with heavy dosage appears to be justified, as a last resort.

Concerning benign giant-cell tumors (grade I), there is no convincing evidence that roentgen therapy alone is curative. Nor is there evidence that "postoperative roentgen therapy is indicated routinely" (8). And we cannot agree that "roentgen therapy correctly administered does not increase the risk of complications" (8). In fact, no satisfactory evidence was found that radiation should be used at all in the treatment of benign giant-cell tumors.

#### SUMMARY

1. A case of giant-cell tumor of the lower femur is reported, with clinical, roentgen, and pathological findings before and after curettage, roentgen therapy, and amputation. Sarcoma was found three years after the first operation, and the patient is living and well five years following amputation.

2. Giant-cell tumor of bone has been recognized as a definite clinical and pathological entity for the past 125 years.

3. The sound teachings of Paget, Nélaton, and Gross, between 1854 and 1879, still hold good on many points.

4. No infallible "typical" roentgen-ray appearance of benign giant-cell tumor of bone is known.

5. The finding of giant-cell tumor by aspiration biopsy does not necessarily exclude sarcoma.

6. Adequate biopsy material and microscopic diagnosis of benign giant-cell tumor do not guarantee that malignant giant-cell tumor or sarcoma may not be found at the same site at a future date.

7. A survey of the literature suggests that recurrences are most frequent following curettage without cauterization or curettage plus roentgen therapy.

8. There appear to be fewer recurrences following complete excision with bone graft or amputation.

9. There is a great need for publication of the end-results of benign giant-cell

tumors, adequately proved by good microscopic sections before roentgen therapy, and treated with roentgen rays alone. Until such reports are made, roentgen therapy cannot be properly evaluated or considered the treatment of choice for giant-cell tumor of the long bones.

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#### REFERENCES

1. ALEXANDER, EMORY, G., AND CRAWFORD, WILLIAM H.: Multiple Giant-Cell Tumors: Report of Case and Review of Literature. *Ann. Surg.* 86: 362-373, 1927.
2. AUGÉ, A., AND ROUX, G.: Tumeur du fémur à éléments géants; amputation haute; récurrence in situ et généralisation en deux mois. *Bull. de l'Assoc. franç. p. l'étude du cancer* 11: 616-628, 1922.
3. BAETJER, FREDERICK H.: Differential Diagnosis of Bone Tumors. *Am. J. Roentgenol.* 5: 260-264, 1918.
4. BLOODGOOD, JOSEPH C.: Benign Bone Cysts, Osteitis Fibrosa, Giant-Cell Sarcoma, and Bone Aneurism of the Long Pipe Bones. *Ann. Surg.* 52: 145-185, 1910.
5. BLOODGOOD, JOSEPH C.: The Conservative Treatment of Giant-Cell Tumor, with Study of Bone Transplantation. *Ann. Surg.* 56: 210-239, 1912.
6. BLOODGOOD, JOSEPH C.: Bone Tumors. *Ann. Surg.* 69: 345-359, 1919.
7. BORAK, J.: Röntgentherapie bei Knochengeschwülsten. *Strahlentherapie* 33: 435-440, 1929.
8. BRUNSCHWIG, ALEXANDER: Observations on the Changes Occurring at Benign Giant-Cell Tumor Sites Several Years Following Treatment by Conservative Measures. *Am. J. Roentgenol.* 40: 817-827, 1938.
9. CHATTERTON, C. C., AND FLAGSTAD, A. E.: Peculiar Behavior of Giant-Cell Tumors. *J. Bone & Joint Surg.* 9: 111-118, 1927.
10. CODMAN, E. A.: Bone Sarcoma: Prevalence in Massachusetts. *Boston M. & S. J.* 187: 543-545, 1922.
11. CODMAN, E. A.: Bone Sarcoma. New York, Paul B. Hoeber, Inc., 1925.
12. CODMAN, E. A.: Epiphyseal Chondromatous Giant Cell Tumors of the Upper End of the Humerus. *Gynec. & Obst.* 52: 543-548, 1931.
13. CODMAN, E. A.: Treatment of Giant Cell Tumors about the Knee; Study of 153 Cases Collected by Registry of Bone Sarcoma of American College of Surgeons. *Gynec. & Obst.* 64: 485-496, 1937.
14. COLEY, BRADLEY L., AND MILLER, LAWSON, E.: Atypical Giant Cell Tumor. *Am. J. Roentgenol.* 47: 541-548, 1942.
15. COLEY, WILLIAM B.: The Influence of the Roentgen Ray upon the Different Varieties of Sarcoma. *Am. Med.* 4: 251-255, 1902.
16. COLEY, WILLIAM B.: Trial Results in the X-Ray Treatment of Cancer, Including Sarcoma. *Ann. Surg.* 42: 161-184, 607-610, 1905.
17. COLEY, WILLIAM B.: Prognosis in Giant-Cell Sarcoma of the Long Bones. *Ann. Surg.* 79: 321-357, 1924.
18. COLEY, WILLIAM B.: Prognosis and Treatment of Giant-Cell Sarcoma Based on a Further Study of End Results in Sixty-nine Cases. *Ann. Surg.* 86: 641-665, 1927.
19. COLEY, WILLIAM B.: Malignant Changes in the So-Called Benign Giant-Cell Tumor. *Am. J. Surg.* 28: 768-820, 1935.

20. COOPER, ASTLEY, AND TRAVERS, BENJAMIN: Surgical Essays. Philadelphia, James Webster, 1821, pp. 125-166.
21. DOUTH, HOWARD P., HARTMAN, F. W., AND MITCHELL, C. L.: Immediate and End-Results of Radiation Therapy in Certain Benign Bone Tumors. *Radiology* 30: 420-436, 1938.
22. DYKE, S. C.: Metastasis of the "Benign" Giant-Cell Tumour of Bone (Osteoclastoma). *J. Path. & Bact.* 34: 259-263, 1931.
23. EVANS, WILLIAM A., AND LEUCUTIA, T.: Value of Roentgen-Ray Therapy in Primary Malignant Tumors and Benign Giant Cell Tumor of Bone. *Am. J. Roentgenol.* 20: 303-338, 1928.
24. EWING, JAMES: Neoplastic Diseases. Philadelphia, W. B. Saunders Co., Fourth Edition, 1940, pp. 318-327.
25. EWING, JAMES: A Review of the Classification of Bone Tumors. *Surg., Gynec. & Obst.* 68: 971-976, 1939.
26. FINCH, E. F., AND GLEAVE, H. H.: Osteoclastoma (Myeloid Sarcoma, Benign Giant-Cell Tumor) with Pulmonary Metastases. *J. Path. & Bact.* 29: 399-406, 1926.
27. GESCHICKTER, CHARLES F., COPELAND, MURRAY M., AND BLOODGOOD, J. C.: Osteitis Fibrosa and Giant-Cell Tumor. *Arch. Surg.* 19: 169-271, 1929.
28. GESCHICKTER, CHARLES F., AND COPELAND, MURRAY M.: Recurrent and So-Called Metastatic Giant Cell Tumor. *Arch. Surg.* 20: 713-755, 1930.
29. GESCHICKTER, CHARLES F., AND COPELAND, MURRAY M.: Tumors of Bone (Including Jaws and Joints). Published by Am. J. Cancer, New York, 2nd ed., 1936, pp. 287-377.
30. GOFORTH, J. L.: Giant-Cell Tumor of Bone. *Arch. Surg.* 13: 846-870, 1926.
31. GREENOUGH, R. B., SIMMONS, C. C., AND HARMER, T. W.: Bone Sarcoma. *J. Orth. Surg.* 3: 602-637, 1921.
32. GROSS, SAMUEL W.: Sarcoma of the Long Bones; Based upon a Study of 165 Cases. *Am. J. M. Sc.* 78: 17-57, 1879.
33. HENDERSON, M. S.: Giant-Cell Tumor of the Upper End of the Femur: Report of Three Cases. *Minnesota Med.* 11: 542-547, 1928.
34. HERENDEEN, RALPH E.: The Roentgen Ray in the Treatment of Giant-Cell Tumors. *Am. J. Roentgenol.* 12: 117-125, 1924.
35. HERENDEEN, RALPH E.: Results in the Röntgen Therapy of Giant-Cell Tumors of Bone. *Ann. Surg.* 93: 398-411, 1931.
36. HERENDEEN, RALPH E.: Diagnosis and Results in the Radiation Treatment of Some Medullary Bone Tumors. *Radiology* 7: 140-143, 1926.
37. HINDS, FRANK: Case of Myeloid Sarcoma of the Femur Treated by Scraping. *Brit. M. J.* 1: 555, 1898.
38. JAFFE, H. L.: Hyperparathyroidism. *Bull. New York Acad. Med.* 16: 291-311, 1940.
39. JAFFE, H. L., LICHTENSTEIN, L., AND PORTIS, R. B.: Giant Cell Tumor of Bone: Its Pathologic Appearance, Grading, Supposed Variants and Treatment. *Arch. Path.* 30: 993-1031, 1940.
40. KARSNER, HOWARD T.: Human Pathology. Philadelphia, J. B. Lippincott Co., 6th ed., 1942, pp. 311-312.
41. KING, E. S. G.: Malignant Giant-Cell Tumor of Bone. *Brit. J. Surg.* 20: 269-278, 1932.
42. KIRKLIN, B. R., AND MOORE, C.: Roentgenologic Manifestations of Giant-Cell Tumor. *Am. J. Roentgenol.* 28: 145-150, 1932.
43. KLEINBERG, SAMUEL J.: Malignant Giant-Cell Tumor of Bone: Report of Case Involving Tibia. *J. Bone & Joint Surg.* 21: 433-441, 1939.
44. KOLODONY, ANATOLE: Bone Sarcoma. Chicago, Surgical Publishing Co., 1927, pp. 172-214.
45. LEBERT, H.: Des tumeurs fibro-platiques ou sarcomateuses physiologie pathologique. Paris, J. B. Baillière et fils, Vol. 2, 1845, pp. 120.
46. LEWIS, DEAN: Primary Giant-Cell Tumors of Vertebrae. *J. A. M. A.* 83: 1224-1229, 1924.
47. MACGUIRE, C. J., JR., AND MCWHORTER, J. E.: Sarcoma of Bone: Analysis of Fifty Cases. *Arch. Surg.* 9: 545-592, 1924.
48. MALLORY, F. B.: Giant-Cell Sarcoma. *J. M. Research* 24: 463-467, 1911.
49. MARTLAND, H. S.: Primary Bone Tumors; Their Classification, with Special Reference to Benign Giant-Cell Tumor. *Proc. New York Path. Soc.* 21: 102-113, 1921.
50. MEYERDING, H. W.: Benign Foreign Body Giant-Cell Tumors in the Long Bones. *J. A. M. A.* 83: 1323-1329, 1924.
51. MEYERDING, H. W.: Benign and Malignant Giant-Cell Tumors of Bone: Diagnosis and Result of Treatment. *J. A. M. A.* 117: 1849-1855, 1941.
52. MORTON, J. J., AND DUFFY, W. C.: A Clinical and Pathologic Study of Ten Bone Tumors. *Arch. Surg.* 7: 469-531, 1923.
53. MOSCHOWITZ, E.: Relation of Angiogenesis to Ossifications. *Bull. Johns Hopkins Hospital* 27: 71-78, 1916.
54. NÉLATON, EUGÈNE: Mémoire sur une nouvelle espèce de tumeurs à myéloplaxis. Paris, Adrian Delahaye, 1860.
55. ORR, J. W.: Malignant Osteoclastoma. *J. Path. & Bact.* 34: 265-266, 1931.
56. PAGET, JAMES: Surgical Pathology. Philadelphia, Lindsay & Blakiston, 1854, Lectures 27-28, pp. 421-466.
57. PEIRCE, CARLTON B.: Giant-Cell Bone Tumor. *Am. J. Roentgenol.* 28: 167-188, 1932.
58. PFAHLER, GEORGE E., AND PARRY, LEO D.: Treatment of Giant-Cell Bone Tumors by Roentgen Irradiation. *Am. J. Roentgenol.* 28: 151-166, 1932.
59. PIEMISTER, DALLAS B.: Chondrosarcoma of Bone. *Surg., Gynec. & Obst.* 50: 216-233, 1930.
60. PLATOU, E.: On Osseous Cysts and So-Called Giant-Cell Sarcoma. *Ann. Surg.* 67: 312-330, 1918.
61. SIMMONS, C. C.: Malignant Changes Occurring in Benign Giant Cell Tumors of Bone. *Surg., Gynec. & Obst.* 53: 469-478, 1931.
62. SIMMONS, C. C.: Primary Malignant Bone Tumors; Differential Diagnosis; Its Importance in the Selection of Treatment. *Am. J. Surg.* 27: 19-25, 1935.
63. SOSMAN, MERRILL C.: Giant-Cell Tumor of the Radius with a Poor Result from Roentgen Therapy: Case Report. *Am. J. Roentgenol.* 22: 346-349, 1929.
64. STEWART, FRED W., COLEY, B. L., AND FARROW, J. H.: Malignant Giant Cell Tumor of Bone. *Am. J. Path.* 14: 515-536, 1938.
65. STEWART, MATTHEW J.: Observations on Myeloid Sarcoma, with an Analysis of Fifty Cases. *Lancet* 2: 1236-1242, 1914.
66. STEWART, MATTHEW J.: Large Myeloid Sarcoma (Myeloma) of the Radius in Which the Tumor Is White Throughout. *Brit. J. Surg.* 10: 322-325, 1923.
67. STONE, W. S., AND EWING, JAMES: An Unusual Alteration in the Natural History of a Giant Cell Tumor of Bone. *Arch. Surg.* 7: 280-296, 1923.
68. TURNER, W. G., AND WAUGH, T. R.: Giant Cell Sarcoma of the Femur (Epulis Type) with Metastasis in the Femoral Vein. *Ann. Surg.* 78: 846-852, 1923.
69. VIRCHOW, RUDOLPH: Die Krankhaften Geschwülste. Berlin, August Hirschwald, 1865, Vol. 2, pp. 213 and 332.

# Tissue Changes Produced in C3H Mice by 50 r Whole Body Exposure<sup>1</sup>

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STRONG INTEREST is manifested today in the effects of small-dose irradiation on the animal body. This is because such exposures may be of common occurrence, and the cumulative action may bring about serious injury. Tissue and blood changes produced by larger doses of radiation have been adequately described (1, 4, 8). There appears to be general agreement on such points as the following: (1) The more sensitive tissues of the body are the lymph nodes and gonads; the bone marrow, intestinal mucosa, and skin being only slightly more resistant. (2) The blood picture is altered by radiation, and this alteration reflects in some manner the extent of tissue damage. (3) The degree of tissue injury varies with the dose of radiation applied. (4) Partial or complete recovery will occur in animals which survive the injury. (5) Histologically, high doses produce necrosis of cells with loss of functional elements and over-proliferation of fibrous connective tissue.

Thus far not much attention has been directed toward the study of changes produced by smaller doses of x-rays. It is not known, for example, what constitutes the threshold injurious dose for the more susceptible tissues, what are the earliest histologic changes, or how long such changes may persist. Furthermore, from a more practical point of view, it is not known whether the early tissue changes are reflected in the blood picture. It is our purpose to deal with some of the threshold modifications induced in tissues and blood by small doses of hard x-rays. Although threshold changes are difficult to detect histologically, we shall describe the

modifications which appeared to be clearly an effect of x-rays, presenting these on a time basis.

A single small dose of x-rays may produce significant tissue changes, intermittent exposures being to some extent additive. Such changes may also result from treatments applied locally. In order to study these aspects, the first step is to investigate the effects of a small acute dose applied to the whole body.

## METHODS AND MATERIALS

Since extensive morphologic studies are impractical in man, experimental approaches in animals were sought, and the mouse was decided upon. Young adult male C3H mice from an inbred colony (maintained by Dr. J. W. Thompson, National Cancer Institute) were used. From a series of preliminary experiments it was found that doses of 50 r produced faintly detectable tissue and blood change. Hence 50-r doses were used in the study reported herein. The treatment conditions were: 200 kv., 20 ma., 0.5 mm. copper, 1.06 mm. aluminum filter, 105.3 cm. distance, 8 r per minute (measured in air), exposure time 6.18 minutes.

Blood counts were made and tissues were fixed at the following times after irradiation: 1, 2, 4, 8, 12, and 24 hours, 2, 4, 7, 10 and 14 days. The blood studies consisted of total leukocyte and differential counts. Pre-experimental control counts were made on all animals. During the experiment three animals were examined each time a count was made and enough were used so that it was not necessary to repeat the examinations more often than once a week. Three animals were killed at each time interval for the tissues, which were fixed. Zenker-formol fixative and

<sup>1</sup> Presented before the Radiological Society of North America at the Twenty-eighth Annual Meeting, Chicago, Ill., Nov. 30-Dec. 4, 1942.

hematoxylin-eosin stains were used exclusively. For the most part the following tissues were examined: lymph nodes, sternum, spleen, thymus, testes, intestine, stomach, lung, kidney, liver, and skin.

### RESULTS

*Hematologic Picture:* The blood changes observed are recorded in Figure 1. The abscissas show time in days and the ordinates the number of cells in each instance. The upper graph pertains to the total leukocyte count, the middle one to total lymphocytes, and the lower to total neutrophils. The average (arithmetic mean) leukocyte precount value was 11,550, the range being 7,850 to 15,820, and the average deviation from the mean  $\pm 1,640$ . The dotted line of the graph represents the level of the average precount value. Likewise, the average lymphocyte value was  $6,800 \pm 640$  (range 3,460 to 11,100) and the average neutrophil value was  $4,550 \pm 470$  (range 2,500 to 6,620). The levels for the average lymphocyte and neutrophil values are also shown by dotted lines in the respective graphs.

There is evidence of an abrupt rise in all of the curves followed by a sharp fall. The leukocyte fall reaches the lowest level at about the fourth or fifth day, and there is an indication that a slight leukopenia is present during most of the period of observation. Lymphocyte and neutrophil curves show more precisely what happened. It will be seen that the leukopenia was mainly or exclusively lymphopenia and that the latter persisted throughout the course of the observations. Hence it becomes clear that while the small dose of 50 r, as used, will cause a fall in lymphoid elements of the mouse's blood, the myeloid cells are little affected. Moreover, it is evident that a period of more than two weeks is required for recovery from the comparatively mild lymphopenia.

*General Histologic Changes:* There was a brief generalized two-hour vasodilatation. The earliest discernible tissue change was an eosinophilia and cloudy swelling of the cytoplasm with poor staining of the

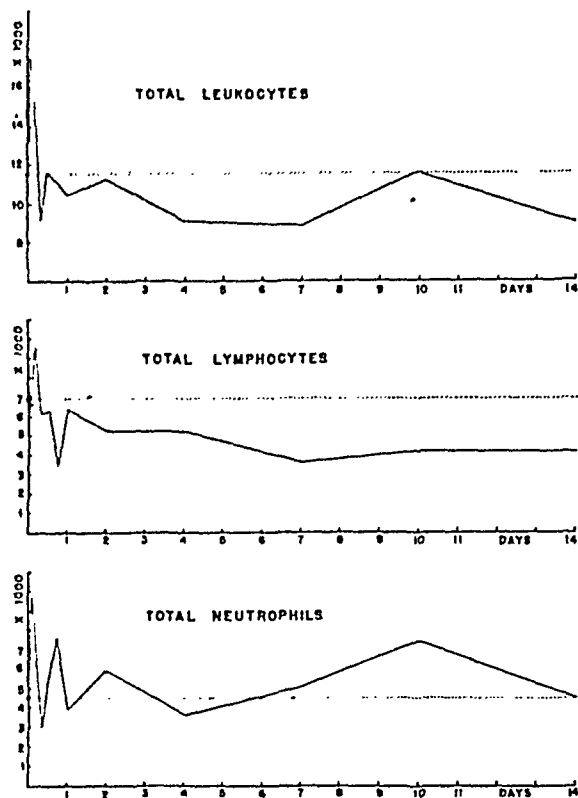


Fig. 1. Curves showing blood changes. The abscissas indicate time in days and the ordinates the number of cells in each instance.

nuclei. Upon further study, it was found that by staining fresh sections with varying intensity the relative cellular eosinophilic shift was always constant and that it occurred in all tissues. It was seen in the tissues fixed at one hour and its persistence ran a varying course depending upon the type of tissue, being lost at eight hours in spinal cord and ganglia and lasting as long as twelve hours in intestinal mucosa and bone marrow. With the disappearance of the eosinophilia, the cytoplasmic swelling and hyperchromia of the nuclei shifted to the basic side, with final return to normal staining of all tissues at twenty-four to forty-eight hours. This whole change was considered to be a very mild form of parenchymatous degeneration which returned rapidly to normal.

*Lymph Nodes and Spleen:* The one-hour material showed considerable swelling of the primitive monocytes, the accumulation of which produced wedge-shaped sheets of cells about the periphery of the



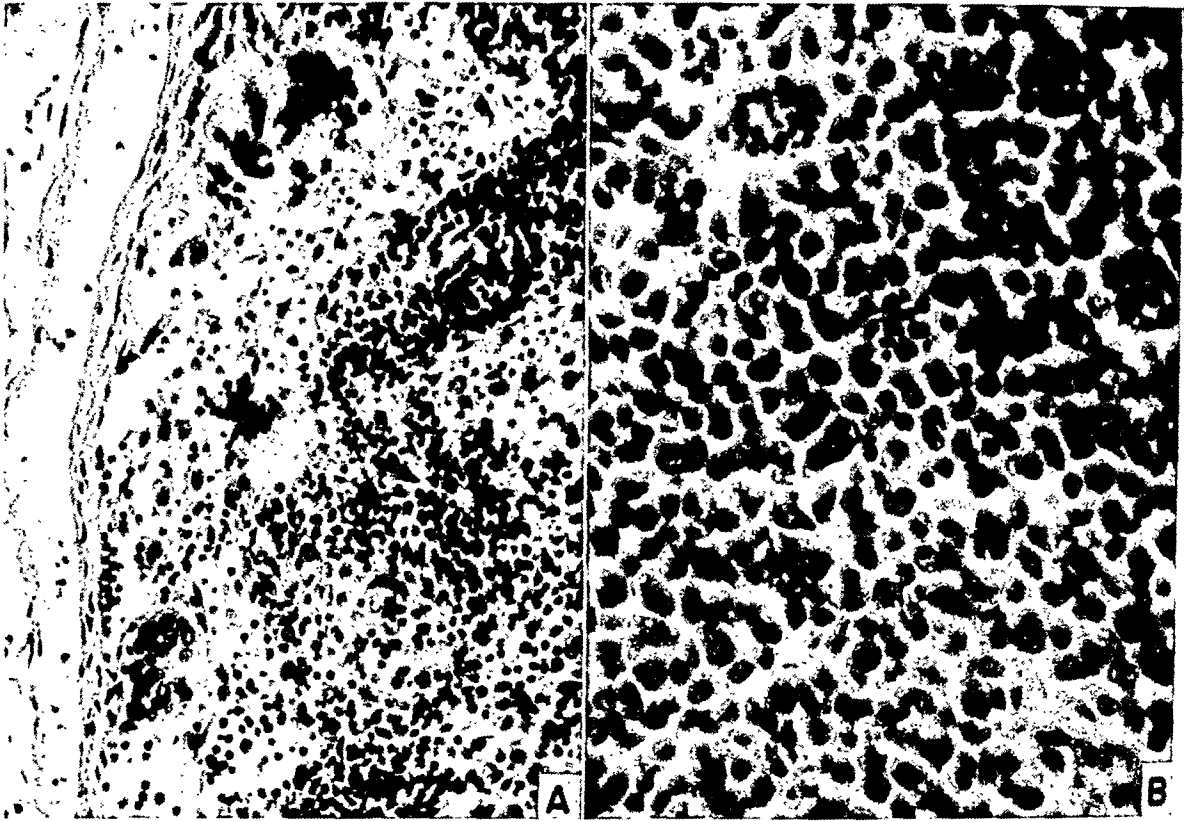


Fig. 2. A. Photomicrograph of the periphery of a mouse lymph node twenty-four hours after irradiation. Edema is marked; the monocytes are especially prominent, many of them lying free in sinusoids. Sinusoidal packing with lymphocytes is seen. Two multinucleated giant cells lie beneath the capsule.  $\times c.115$ . Hematoxylin and eosin stain.

B. Higher-power magnification of a lymph node twelve hours following irradiation. Flecks of necrosis with polymorphonuclear leukocyte infiltration are seen.  $\times c.275$ . Hematoxylin and eosin stain.

nodes. Many of these cells became detached and were set free in the sinusoids. As early as four hours after treatment multiple flecks of necrosis appeared in the germinal follicles, marked by small, tightly circumscribed groups of polymorphonuclear cells (Fig. 2B). Multinucleated giant cells occurred after four hours and as late as three days. Due to their rapid appearance and since transitional forms were seen, these were considered to be formed by fusion of monocytes (Fig. 2A) for the following reasons. Between eight and twelve hours the minute necrotic foci and the edema tended to disappear, giving way at the end of this time to an increased cellularity of the nodes. Some of the multinucleated cells present at this stage contained as many as forty nuclei. No clear mitotic wave was found, although the eight-hour and twelve-hour material suggested an excess of mitotic figures. The spleen showed changes

similar to those in the lymph nodes, together with an increase in megakaryocytes. Pigment-containing monocytes were found in significant numbers in the spleen and lymph nodes at sixteen hours. Beyond this time no other histologic abnormalities were noted except the occasional multinucleated cells which persisted through the third day.

*Bone Marrow:* Changes in the bone marrow were less pronounced and lagged behind those in the lymph nodes. The earliest well defined modifications were found at eight hours. Instead of flecks of necrosis more cells of the adult myeloid series than normal were found. This suggested that minimal destruction had occurred unobserved at an earlier time. Megakaryocytes became abundant at twelve hours, and there was at this time a definite increase in myeloblasts. Some of the megakaryocytes showed bizarre nuclear configurations as late as seven

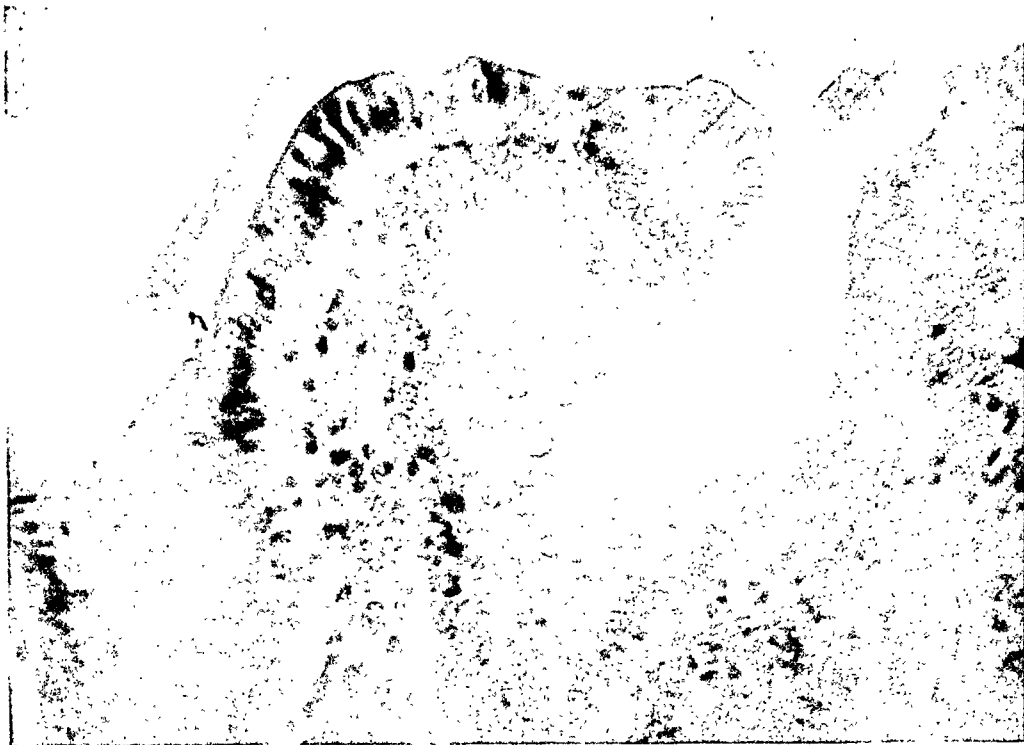


Fig. 3. Mucosa taken from the ileum one hour following irradiation. The edema is marked by the smoothness in outline of the villus and the general cloudiness of the cells.  $\times c.165$ . Hematoxylin and eosin stain.

days. Increased vascularity, while prominent early, never became extensive in the late stages to the same degree as observed in other tissues. The increased alkalinity lasted as long as two to four days, and the megakaryocyte abnormalities considerably longer. Otherwise the tissue was histologically normal.

*Ileum (lower portion):* Edema was pronounced in the mucosa of the ileum due to the looseness of mucosal structure. Swelling occurred as early as two to four hours and was characterized by marked hydropic changes in the inner luminal cells of the villi, cells lining the deeper crypts being less affected. The cell swelling produced rounded protuberances on the villi (Fig. 3). The cells became vague in outline, and acid staining of the cytoplasm together with poor nuclear staining were seen. The swelling and abnormal staining lasted only a short time, with a return to normal within eight to twelve hours. No other significant changes were observed.

*Testes:* In the mouse testes under nor-

mal conditions there is marked variability in the mitotic activity from one seminiferous tubule to another (6). This may account for the variation in histologic pattern seen in different tubules. The following is as nearly a composite picture as could be gained. First, there was a general cell swelling as described for other tissues, with a proportional increase in the secondary spermatogenic cells at one to two weeks. During the period four to eight day, spermatogenic cells in some of the tubules appeared ragged and pyknotic, and large irregularly shaped nuclei made their appearance (Fig. 4). Even at the most destructive phase the majority of the tubules showed normal spermatogenesis. By the end of three weeks the testes had returned to normal.

*Other Tissues:* No significant changes other than those already described were noted.

*Control Tissues:* None of the changes described above could be found upon examination of adequate control materials.

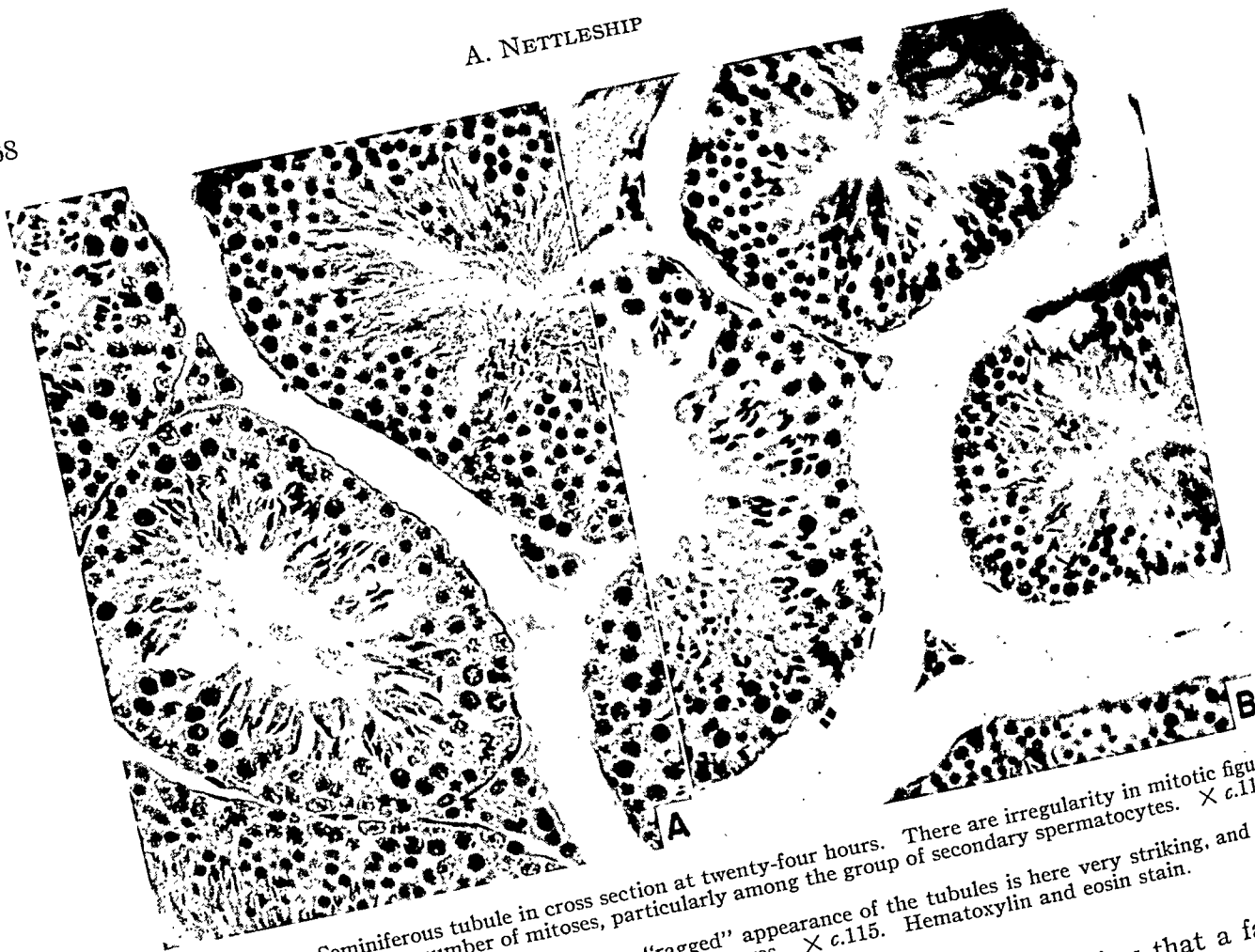


Fig. 4. A. Seminiferous tubule in cross section at twenty-four hours. There are irregularity in mitotic figure size and reduction in the number of mitoses, particularly among the group of secondary spermatocytes.  $\times c.115$ . Hematoxylin and eosin stain.  
B. Seminiferous tubule at one week. The "ragged" appearance of the tubules is here very striking, and the top tubule shows a considerable reduction in mitotic figures.  $\times c.115$ . Hematoxylin and eosin stain.

#### DISCUSSION

By an early and systematic examination of the tissues of animals exposed to doses of 50 r (whole body exposure), slight but well defined and widespread changes were discovered. These changes lasted only a short time (from a few hours to several days), but they proved to be sufficiently consistent in occurrence to warrant the belief that they arose from the application of the x-rays. This belief is further warranted by the fact that any cell injury appears to bring about a lowering of pH with an increase of cytoplasmic acidity. Such a change is known to produce eosinophilia of the cell together with swelling and loss of clarity in cell outline similar to that seen in our material. Thus the cells in all tissues which we examined would seem to have suffered a mild form of damage, the majority surviving and quickly returning to normal.

In contrast with the view that a fairly long lag period may occur between the time of tissue breakdown and a shift in the peripheral blood picture (8), these experiments showed a close relationship between the occurrence of central tissue damage and an altered blood picture; flecks of necrosis occurred in the lymph nodes as early as eight hours, and the lymphopenia began at very nearly the same time. Although a brief leukocytosis was obtained, the response was irregular and quickly settled into a persisting leukopenia (prolonged lymphocytosis following repeated irradiation, has, however, been reported by Nakahara and Murphy, 7). The splenic changes were not so marked as those found in the nodes but followed the same general trend. The bone marrow changes were not so great as those in the lymph nodes and occurred at a later time. The occurrence of apparently greater radiore-

sistance of bone marrow, together with an excess in number of adult forms, is not unlike the findings obtained with higher dosages (4). It is of interest that, despite absence of histologic evidence of abnormality in the lymphoid tissues after one week, functionally there still existed a lymphopenia.

Although previous writers have spoken of early edema of intestinal mucosa following irradiation, their reports have referred to results obtained with larger dosages (200 to 400 r or more), and they have shown that the strongest modifications occurred at four days (2). With the small dose of 50 r used here, the effects (slight swelling and eosinophilia) were most pronounced at four to eight hours, the return to normal being rapid. This suggests that the duration of the injury varies with the dose, that is, with the amount of injury.

Certain sections of the seminiferous tubules showed moderate destructive changes. The variation in radiosensitivity of the spermatocytes, as well as the destruction of the basal cells, has previously been described (3, 9). The destructive changes, though never great, increased steadily over a period of twenty-four to forty-eight hours and required several days to disappear completely.

In conclusion, it is clear that distinct and definite histologic damage is produced by acute doses of 50 r applied to the whole body of the mouse. Furthermore, it is clear that, for the most part, the tissues showing the greatest sensitivity to large doses of radiation are the only ones histologically affected when small doses are used.

#### SUMMARY

1. Whole body exposure of C3H mice to 50 r of hard x-rays produced the following tissue changes:

(a) Swelling and eosinophilic staining of the cell cytoplasm with reduced nuclear staining; later slight hyperchromia of the cell and nucleus; final return to normal.

(b) Destruction of cells within the lymph

node follicles, followed by a mild hyperplasia.

(c) Altered blood picture consisting of a momentary leukocytosis turning within eight to twelve hours into a mild but persisting lymphopenia.

(d) Reduction of mitotic rate and destruction of spermatogenic cells, with slow return to normal.

2. Since these changes represent only small deviations from the normal, they may be regarded as threshold irradiation effects.

3. The various effects appear at different times and last for varying periods.

4. Changes in the blood picture appear to follow closely the onset of damage to hemopoietic tissues but to persist beyond the period of hemopoietic tissue damage.

5. The evidence presented indicates that a lymphocyte count of the peripheral blood will give evidence of threshold tissue injury due to irradiation, whereas the leukocyte or neutrophil count would probably fail to reveal it.

#### BIBLIOGRAPHY

1. DESJARDINS, A. U.: Radiosensitiveness of Cells and Tissues and Some Medical Implications. *Science* 75: 539-575, June 3, 1932; *Arch Surg.* 25: 926-942, November 1932.
2. ENGELSTAD, R. B.: Effect of Roentgen Rays on the Stomach in Rabbits. *Am. J. Roentgenol.* 40: 243-263, August 1938.
3. FERROUX, R., AND REGAUD, C.: Est-il possible de stériliser le testicule du lapin adulte par une dose massive de rayons X sans produire de lésion grave de la peau? *Compt. rend. Soc. de biol.* 97: 330-333, July 8, 1927.
4. HEINEKE, H.: Ueber die Einwirkung der Röntgenstrahlen auf innere Organe. *München. med. Wehnschr.* 51: 785, 1904. *Experimentelle Untersuchungen über die Einwirkung der Röntgenstrahlen auf das Knochenmark, nebst einigen Bemerkungen über die Röntgentherapie der Leukämie und Pseudoleukämie und des Sarkoms.* *Deutsch. Ztschr. f. Chir.* 78: 196, 1905.
5. LINGLEY, J. R., GALL, E. A., AND HILCKEN, J. A.: Comparative Experimental Studies of 200 Kilovolt and 1,000 Kilovolt Roentgen Rays. II. Biological Effects on the Bone Marrow of the Albino Rat. *Am. J. Path.* 16: 845-854, November 1940.
6. MAXIMOW, A. A.: *A Textbook of Histology.* Philadelphia, W. B. Saunders Co., 1930.
7. NAKAHARA, W., AND MURPHY, J. B.: Studies on X-ray Effects. X. Biological Action of Small Doses of Low Frequency X-rays. *J. Exper. Med.* 35: 475-486, April 1922.
8. DUNLAP, C. E.: Effects of Radiation on Normal Tissues, III. Effects of Radiation on the Blood and the Hemopoietic Tissues. *Arch. Path.* 34: 562, 1942.
9. WIGODER, S. B.: Effect of X-rays on the Testis. *Brit. J. Radiol.* 2: 213-221, May 1929.

## A. NETTLESHIP

## DISCUSSION

P. S. Henshaw, Ph.D. (Bethesda, Md.): I should like to make some comments concerning this paper. We have heard a good deal during the past two days, both in regard to protection and in regard to stimulation. After Doctor Pfahler's interesting paper<sup>1</sup> there were remarks pro and con regarding the idea that ionizing radiations may have a stimulating effect. There were objections to this view, and yet it seemed that there were several who were of the opinion that patients who had been given small doses of radiation showed an enhanced sense of well-being and that this constituted evidence for stimulation.

Here Doctor Nettleship has pointed out that definite cell injury may occur after doses of 50 r are applied to the whole body. I wish to raise the

<sup>1</sup> Radiology 41: 468-470, November 1943.

question whether stimulation may not result from just such damage. We are familiar with the stimulation for repair furnished by trauma. Is it not possible that x-rays, through slight destructive action, may furnish stimulus for improvement?

From the standpoint of protection, here is evidence of tissue injury produced by 50 r, a dosage which may be received accidentally by x-ray workers as well as others. Thus the old question is again raised as to whether the injurious effects of small doses of x-rays are additive. In our laboratory we have exposed mice to 5 r per day, applied five times a week. It was found that, whereas the animals remained vigorous and active, their life span was shortened. One is impressed then by the possibility that small amounts of injury, such as those described by Doctor Nettleship, may add up eventually to effects which are not stimulating but seriously injurious.



# Determination of the Position of Calcium Deposits and Foreign Bodies from Stereoscopic Films Without the Use of a Viewing Stereoscope<sup>1</sup>

MAJOR SAM LEVI, M.C., A.U.S.

MANY PERSONS have a poor sense of stereoscopic perception. For these persons localization of the depth of a given shadow may be impossible by the usual method of viewing stereoscopic roentgenograms. In such cases fluoroscopic methods may help. In some locations, however, shadows are not easily studied

relationship to the object-film distance (Fig. 1). This relationship is expressed by the curves in Figure 3. The geometric equation for Figure 1 is derived as follows:

Where  $T_1T_2$  = tube shift,  $T$  = target,  $O$  = object,  $S_1S_2$  = shadow shift,  $F$  = film, since  $T_1OT_2$  and  $S_2OS_1$  are similar triangles,

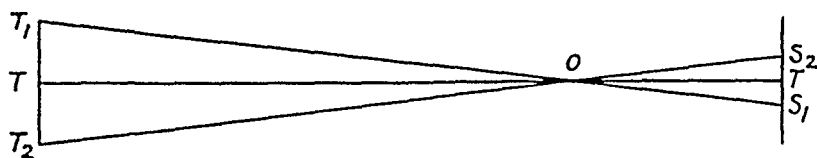


Fig. 1.

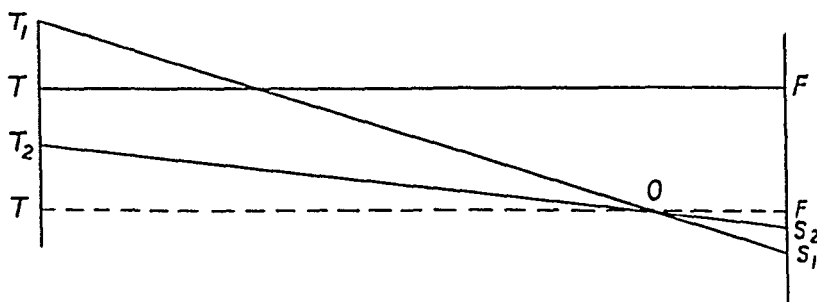


Fig. 2.

fluoroscopically and in some instances they are not of sufficient density to be localized by this means. It would appear, therefore, that a method for determining depth by actual measurement on the stereoscopic roentgenograms would be of value to persons with poor stereoscopic perception. It would be of interest, also, to others who might wish to check the accuracy of their observations.

When we examine the well known basic principles of stereoscopy, we find that if the tube shift and the target-film distance are constant, the image shift bears a direct

$$S_1S_2 : T_1T_2 :: OF : TO$$

$$S_1S_2 = \frac{T_1T_2 \times OF}{TO}$$

Substituting:

$$S_1S_2 = \frac{T_1T_2 \times OF}{TF - OF}, \text{ or}$$

shadow shift =

$$\frac{\text{tube shift} \times \text{object-film distance}}{\text{target-film distance} - \text{object-film distance}}$$

It should be noted that when the objects are not in the line of the central ray, the same formula will apply (Fig. 2).

<sup>1</sup> Accepted for publication in June 1943.

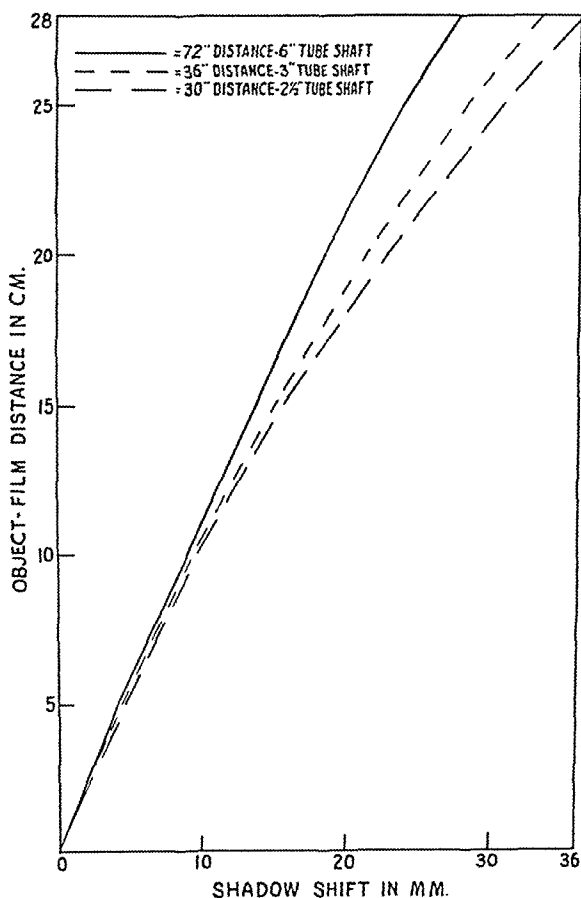


Fig. 3.

By utilizing a number of different object-film distances, the corresponding shadow shifts may be calculated. These, when plotted on co-ordinate paper, produce the curves shown in Figure 3.

Because all images move during stereoscopy, the actual shift of an object cannot be measured unless a known base line is drawn on the films. The distance from the top of the table can be measured, and a shadow known to be on the table, such as the number (or caption), will have a definite displacement for this measured distance, provided it is left undisturbed between exposures. By referring to the proper curve on Figure 3 the caption shift for that particular table top-film distance is obtained. A line is drawn perpendicular to the direction of the tube shift, from a chosen point on the caption to a point beyond the shadow. The distance between the shadow under study and this line is measured on each film. The lesser interval is subtracted from the greater. The

relative shadow shift is thus determined. Then, by adding the caption shift to this (determined from Figure 3, because the caption-film distance is known), the absolute shadow displacement is determined. Referring back to Figure 3, the object-film distance is obtained. Subtracting the table-film distance, the distance of the shadow being studied from the table is determined. Since a given surface of the body has been placed on the table, the distance thus determined is the depth beneath that surface of the body at that point.

For example: given a table-film distance of 5 cm., a target-film distance of 36 inches, and a tube shift of 3 inches, it is desired to learn the depth of a bit of calcium in a pair of stereoscopic roentgenograms (Figs. 4 and 5). From Figure 3 a table-film distance of 5 cm. yields a shift of the caption of 4.3 mm. This is the caption shift.

Drawing a line (a) perpendicular to the caption, we obtain the apparent shadow shift by subtracting the lesser from the greater value ( $4.5 - 4 = 0.5$  cm. or 5 mm.). By adding the shift due to table-film distance (caption shift determined above), the absolute shadow shift is determined ( $4.3 + 5 = 9.3$  mm.). Referring to the chart we learn that a shift of 9.3 mm. represents a depth of 10 cm. By subtracting the table-film distance of 5 cm., the object being studied is thus shown to be 5 cm. from the surface of the skull touching the table.

If the object is dense enough to be seen when the films are superimposed, the method can be simplified by superimposing the captions and then measuring the distance between the shadows on the two films directly. Then, by referring to the curve and adding the table-film factor (in this example 4.3 mm.), the object-film distance can be immediately determined. It must be remembered that this is only true if the caption was placed on the table and not moved between exposures. In a general way, if extreme accuracy is not needed, the actual depth of the object

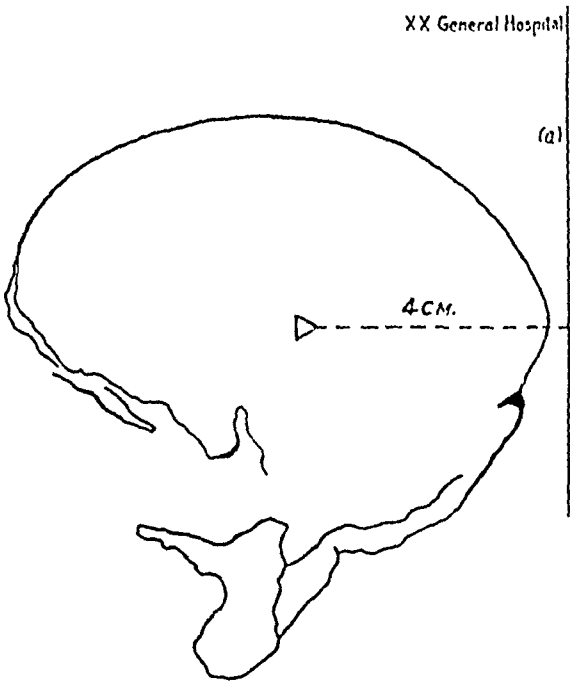


Fig. 4.

on the caption-superimposed films is one centimeter for every millimeter of shift. If we desire to learn the distance of the calcium from the midline, we can superimpose the sella turcica shadows on the lateral projections and measure the image shift. The answer in millimeters equals the number of centimeters from the mid-sagittal plane.

By measuring the relative shift of any two shadows on the films, we can determine the relationship of the objects they represent. The magnitude of error will be determined entirely by the care with

which the measurements of small displacements are made and the accuracy with which the perpendiculars are drawn.

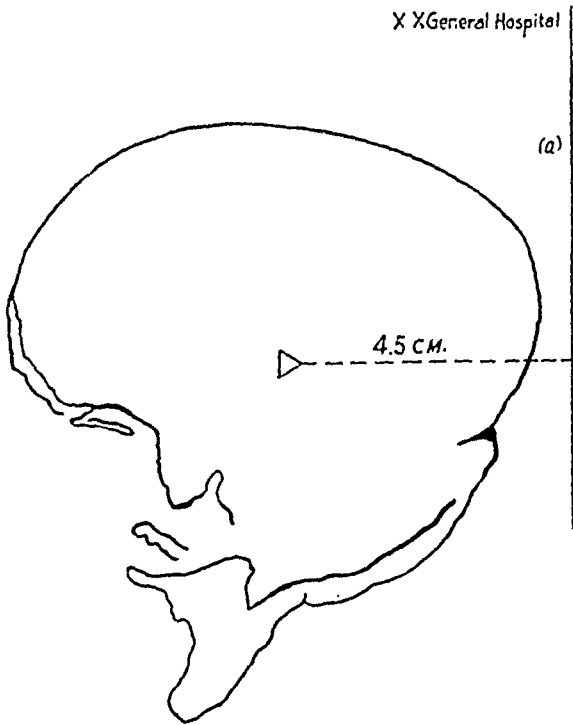


Fig. 5.

SUMMARY

A method for measuring depth from stereoscopic films is presented which requires only a common centimeter ruler. It should be of service to anyone who wishes to check the accuracy of his stereoscopic perception, and to all who have poor stereoscopic vision.



## CASE REPORTS

### Traumatic Serous Cyst of the Lesser Omentum<sup>1</sup>

MILTON BIRNKRANT, M.D.

Assistant Surgeon (R), U. S. Public Health Service

Primary cysts of the omentum are notably infrequent. Horgan (1), in a review of the literature up to 1935, found but 97

in a period covering twenty-three years.

The etiology of serous and hematogenous omental cysts is obscure, though there are many theories (Guernsey, 3). Occasionally a hematogenous omental cyst is preceded by trauma, but this is the exception rather than the rule. Serous omental cysts have been variously interpreted as congenital, lymphogenous, and inflammatory in origin.

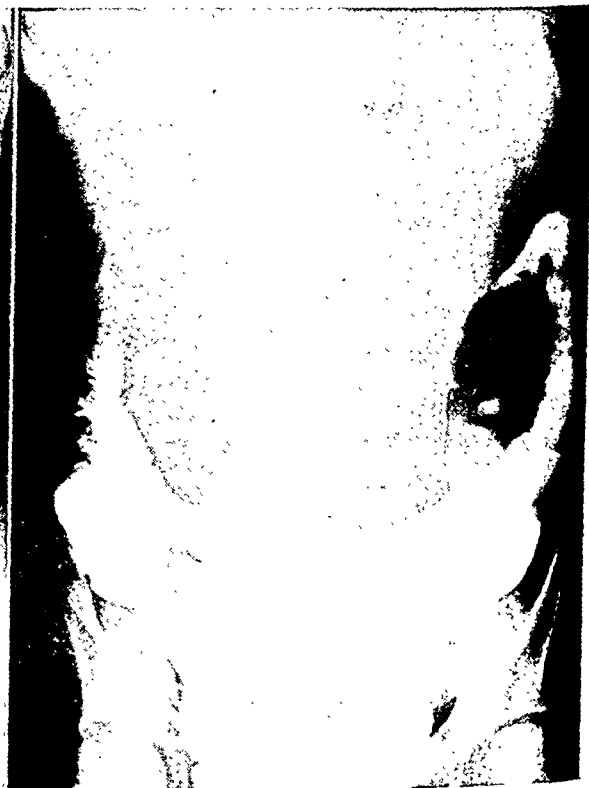


Fig. 1. January 1939, five days after injury. The colon is filled with gas and the transverse arm is at the level of the third lumbar vertebra, a normal finding.

Fig. 2. January 1939, twenty-two days after injury. The barium clyisma shows a depressed transverse colon, with diffuse opacity above, produced by an extrinsic mass.

acceptable cases. Echinococcus cysts are most frequent. Dermoid, lymphogenous, serous, malignant, and traumatic blood cysts are also reported. Berger and Rothenberg (2) found but three omental cysts in the records of the Jewish Hospital of Brooklyn, a 660-bed general hospital,

<sup>1</sup> From the Private Service of Dr. Phillip Miller and the Radiological Service of Dr. Milton G. Wasch, Jewish Hospital, Brooklyn, N. Y. Accepted for publication in June 1943.

In view of our experience, the case reported by Gooding (4) in 1887 is of special interest. He described a serous cyst of the greater omentum "whose origin was obscure but which might have been due to a severe blow sustained some months before." On the assumption that Gooding's case was a traumatic serous omental cyst, the one here reported is the second in the literature.

M. O., a 23-year-old white male, a carpenter, was admitted to the hospital in January 1939. Thirty-six hours previously, while working on a scaffold which gave way, he and his associate fell a distance of 4 feet, striking a pile of bricks. Simultaneously the elbow of the assistant struck the patient's abdomen with considerable force. He immediately experienced epigastric pain, soon followed by severe abdominal colic and persistent vomiting.

On physical examination the patient appeared dehydrated and in obvious pain. He had a temperature of  $100^{\circ}$  but pulse, respiration, and blood pressure were normal. Abdominal palpation revealed a questionable mass in the left upper quadrant with associated resistance and tenderness. Except for the abdominal findings, physical examination was negative. The white blood count ranged from 11,250 to 16,450, with from 76 to 85 per cent polymorphonuclear leukocytes. Several examinations of the urine were negative.

There was gradual abatement of the abdominal pain, and the vomiting, which had been persistent, slowly subsided. The condition then remained stationary until the eighteenth day, at which time there was an acute recurrence of abdominal pain and vomiting. The abdomen increased in size despite the fact that there had been a considerable loss of weight. The abdominal wall was tense and distended but not rigid.

A roentgenogram of the abdomen (Fig. 1), taken five days after injury, revealed a gas-distended colon with the midportion of the transverse colon overlying the third lumbar vertebra. A barium enema (Fig. 2) seventeen days later showed the transverse colon at the level of the lumbosacral articulation. It was concave upward and the haustral markings were lost. There was a diffuse homogeneous opacity in the upper abdomen. The findings were interpreted as indicating an extrinsic mass depressing the transverse colon.

A laparotomy was performed by Dr. Louis Berger two days following the enema study. On opening the peritoneal cavity several ounces of free sanguineous fluid were observed. The upper abdomen was entirely filled by a large round encapsulated mass, which compressed the stomach and displaced it forward. Thromboses in the smaller vessels of the gastric branches of the splenic and the left gastroepiploic veins were present. The gastrocolic omentum was thickened, hemorrhagic, and infarcted. It formed the anterior wall of the tumor, which was identified as a cyst of the lesser omental sac. A needle was introduced and 5,000 c.c. of straw-colored fluid were withdrawn. The cyst collapsed and the walls were marsupialized.

Microscopic examination of the contents of the cyst was negative for chylous fluid. The total lipid content of the fluid was 764 mg. per 100 c.c.

A biopsy specimen from the greater omentum revealed extensive areas of extravasated blood and many markedly engorged blood vessels. Through-



Fig. 3. May 1943. Barium enema now reveals a normal transverse colon. The transverse arm is no longer depressed, and the haze overlying the upper abdomen is not present.

out the tissue there was an infiltration by small round and large mononuclear cells. Some eosinophils and polymorphonuclear leukocytes were also observed. The conclusion of the pathologist was that the omentum showed a chronic inflammatory reaction with a degree of acute activity.

The patient made an uneventful recovery and has been observed over a period of four and one-half years. Roentgen examination in 1943 revealed the transverse colon in normal position with return of the haustral markings (Fig. 3). The opacity in the upper abdomen formerly noted had entirely disappeared. There were no symptoms related to the former illness and the physical examination was negative.

#### COMMENT

The importance of roentgenographic studies of the gastro-intestinal tract as an aid in the diagnosis of omental cyst has been previously emphasized by Lahey and Eckerson (5) and Krupp (6).

The history, radiological, operative, and pathological findings in this case indicate a traumatic serous cyst of the lesser omentum. One may speculate on the possibility of a pre-existing small simple serous cyst,

bnt this would be merely conjecture and the traumatic element would still be of primary importance.

U. S. Public Health Service  
Bethesda 14, Maryland

## REFERENCES

1. HORGAN, J.: Cysts of the Omentum: Review and Report of a Case. *Am. J. Surg.* 29: 343-353, September 1935.
2. BERGER, L., and ROTHENBERG, R. E.: Cysts of the Omentum, Mesentery, and Retroperitoneum: Clinical Studies of 18 Cases. *Surgery* 5: 522-534, April 1939.
3. GUERNSEY, C. M.: Primary Tumors and Cysts of the Omentum. *Proc. Staff Meet., Mayo Clinic* 14: 694-698, Nov. 1, 1939.
4. GOODING, J. C.: Cyst of the Greater Omentum; Removal; Recovery. *Lancet* 1: 311, 1887.
5. LAHEY, F. H., and ECKERSON, E. B.: Retroperitoneal Cysts. *Ann. Surg.* 100: 231-237, July 1934.
6. KRUPP, D. D.: Hematoma of the Gastrohepatic Omentum: X-Ray Plate Suggestive of Carcinoma of the Stomach. *J. Radiol.* 3: 538-539, 1922.

## Multiple Myeloma First Discovered in the Mandible<sup>1</sup>

ERNEST WOLFF, M.D., and LEWIS E. NOLAN, M.D.  
Montgomery, West Va.

The observation and study of a case of multiple myeloma first discovered in the mandible, and apparently arising in that bone, inspired a thorough search of the literature, which failed to disclose a similar case. Myeloma is a rare tumor arising from the blood-forming cells of the bone marrow and at the time of first discovery is nearly always present in more than one bone.

According to Magnus-Levy (1), the order of frequency in which the bones are involved are ribs, vertebrae, sternum, clavicles, upper portions of the femurs, ends of the femurs, innominate bones, base of the skull, and bones distal to the knees and elbows. Cutler, Buschke, and Cantril (2) collected a number of cases which they accept as examples of a single myeloma. They believe that the disease arises as a

single focus and metastasizes. If one accepts their interpretation of myeloma as a true neoplasm, one must conclude that it differs from other tumors in the restriction of metastases principally to other bones. Bell (3) states that small myelomatous foci are occasionally found in the liver, spleen, and lymph nodes but regards these as extramedullary foci of growth and not as true metastases. Myeloma has not infrequently been found microscopically in bones which appeared normal roentgenologically; therefore, one should not necessarily draw the conclusion that the myeloma has its origin in a single focus merely because the roentgen-ray evidence is negative, at the time, in other bones.

A 44-year-old colored married female entered the Clinic in August 1941, complaining of pain and swelling in the left side of the lower jaw of eight weeks' duration. A tooth had become loose over the area of swelling and she had pulled it with a string. Following extraction the swelling became gradually more pronounced and the lower jaw was more painful. She consulted her family physician, who incised the area and, obtaining nothing but blood, referred her to the Tumor Clinic of the Laird Memorial Hospital.

The patient had had the the usual childhood



Fig. 1. Roentgenogram of mandible, showing extent of bone destruction by tumor.

<sup>1</sup> From the Departments of Radiology and Pathology of the Laird Memorial Hospital, Montgomery, West Va. Accepted for publication in June 1943.

diseases and in 1928 underwent hysterectomy for fibromyomata. She was well developed and well nourished, with no remarkable findings aside from the swelling and tumor formation,  $4.0 \times 5.0$  cm., over the alveolar process of the lower left jaw. The pulse and respiratory rates were within normal limits and there was no fever.

Hematological survey disclosed erythrocytes 4,220,000; hemoglobin 13 gm. per 100 c.c. of blood; total leukocytes 6,500 (polymorphonuclear neutrophilic leukocytes 59, lymphocytes 38, monocytes 3, no immature or plasma cells). Attempts were made to demonstrate Bence-Jones protein, but the tests were all negative. The sedimentation rate by the method of Westergren was 55 mm. and 90 mm. for the first and second hours, respectively. Serum calcium, serum phosphate and serum phosphatase were within normal limits. Determination of plasma proteins gave no evidence of hyperproteinemia. The Kline test on the blood was strongly positive (four plus).

X-ray examination of the jaw disclosed a large, sharply defined, circumscribed area of decreased density, involving the greater part of the body of the left mandible, extending from the symphysis to the angle, with only a thin shell of bone remaining at the margin of the tumor (Fig. 1). There was no evidence of new bone formation. X-ray studies of the long bones, ribs, sternum, pelvis, and vertebrae showed no evidence of similar lesions. Roentgenograms of the skull revealed minute, punched-out areas in both parietal bones, the largest of these measuring 3.0 mm. in diameter. The x-ray interpretation was multiple myeloma involving the left side of the mandible and cranium.

The case was the subject of a conference in the Tumor Clinic and a biopsy study was recommended. Tissue was obtained from the area of involvement through the bed of the previously extracted tooth in the left molar region. Macroscopically the material was gray-red and rather soft. Microscopic examination of sections disclosed tissue made up largely of plasma-type cells with a loose cord-like and alveolar arrangement, with thin separating strands of fibrous connective tissue. There were occasional remnants of bone but no evidence of new bone formation. The tissue contained scattered small blood spaces lined with endothelial cells. The plasma-type cells were polygonal and rounded, showing fairly abundant deep pink cytoplasm with hematoxylin and eosin stain. The nuclei were rather large, rounded or oval, and eccentric in position within the cells. The chromatin was deeply hyperchromatic and arranged in blocks forming a cartwheel pattern, radiating toward the center. Very occasional mitotic figures were observed (Fig. 2). Diagnosis: Myeloma, plasma-cell type.

After the diagnosis was established, deep x-ray therapy with 200 kv., 50 cm. distance, filtration of 0.5 mm. copper and 1.0 mm. aluminum, was instituted, 200 r being given daily, alternately through

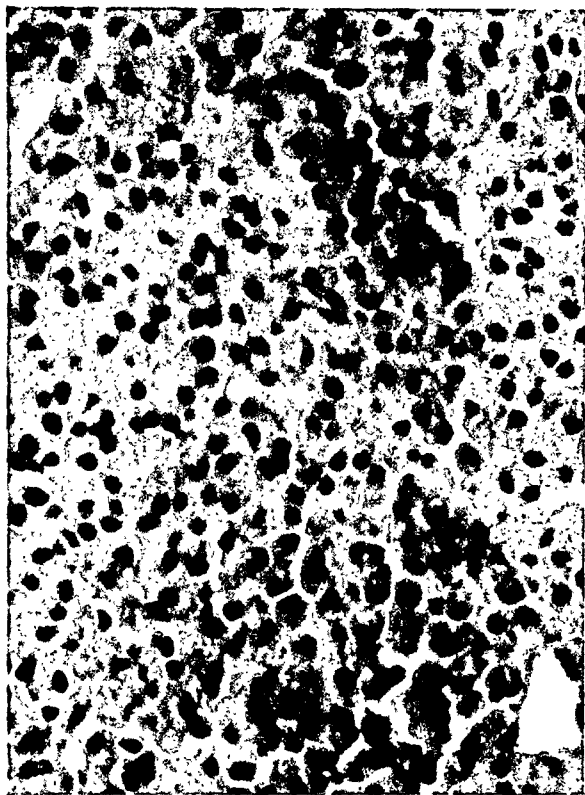


Fig. 2. Biopsy specimen of tumor in mandible, showing plasma-type cells.  $\times c. 500$ .

two portals,  $10 \times 10$  cm., for a period of fourteen days, for a total dosage of 2,200 r. The pain and swelling gradually subsided after 1,500 r had been administered. At the completion of the first series of treatment the face appeared normal and there was no swelling, pain, or tenderness in the mandible. The patient had no complaints. Roentgenograms of the mandible showed no reformation of bone.

The patient was seen at regular intervals and there was no recurrence of the lesion for eighteen months. Roentgenograms taken meantime showed no change in the area of decreased density in the mandible, but films of the skull revealed a gradual increase in size of the punched-out areas of rarefaction previously observed in both parietal bones, with numerous new such areas occurring throughout the cranial vault (Fig. 3). Roentgenograms of all other bones of the body were negative. Frequently repeated tests for Bence-Jones protein were also negative. Hematological surveys disclosed no changes in the blood picture. The patient has gained thirty pounds in weight, has a sense of well being, and is without complaints.

This case has been reported for two reasons: The first is that, to our knowledge, it is the first recorded example of multiple myeloma originating in the man-

dible, which must now be considered in the differential diagnosis of cystic tumors of the jaw. The second is to emphasize the fact that physicians as well as dentists should take biopsies of every non-inflammatory lesion of the gums, alveolar processes, and jaw bones. Because this type

trolled with deep x-ray therapy, with subsidence of swelling and complete relief of pain and tenderness.

4. The patient is living and in good health with no subjective complaints two years after the lesion was first manifest.<sup>2</sup>

5. The importance of biopsy examina-



Fig. 3. Lateral roentgenogram of skull, taken sixteen months after x-ray treatment. The bony defect of the mandible has not been filled in. Multiple punched-out areas in the skull are shown.

of tumor is relatively sensitive to radiation, great local benefit can be obtained, and we believe the life of the patient can be prolonged to an appreciable extent by means of properly administered courses of deep x-ray therapy to the involved areas.

#### CONCLUSIONS

1. A case of multiple myeloma is described, with discovery of the characteristic lesion in the left side of the mandible, with minute, punched-out areas in the parietal bones.

2. Biopsy examination of the mandible disclosed myeloma of plasma-cell type.

3. The lesion in the mandible was con-

tion is stressed in the diagnosis of non-inflammatory lesions of the mouth and jaws.

Laird Memorial Hospital  
Montgomery, West Va.

#### REFERENCES

1. MAGNUS-LEVY, A.: Über die Myelomkrankheit: Beiträge zur Klinik und Pathologie. *Ztschr. f. klin. Med.* 121: 533-562, 1932.
2. CUTLER, MAX, BUSCHKE, FRANZ, AND CANTRIL, S. T.: Course of Single Myeloma of Bone: Report of 20 Cases. *Surg., Gynec. & Obst.* 62: 918-932, June 1936.
3. BELL, E. T.: A Text Book of Pathology. Philadelphia, Lea & Febiger, 3d ed., 1938, p. 300.

<sup>2</sup> After this report was in type, the patient was re-admitted (November 1943), with metastases throughout the skeleton.

## Tabetic Arthropathy of the Hip<sup>1</sup>

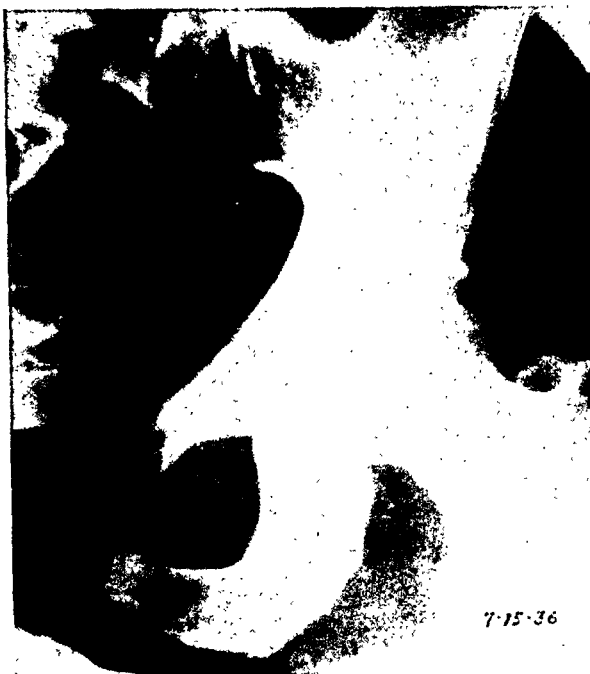
CAPT. IRVING WOLIN, M.C., A.U.S.

Station Hospital, Camp Beale, Calif.

The following report of a Charcot hip is submitted because the roentgenograms afford an opportunity of observing the progress of the disease from a very early stage up to the phase of complete disorgani-

bruing her left thigh. Since this injury she had been unable to sustain her weight on the left leg, because of instability. The limb was painless. She had had tabes dorsalis for twenty-six years, with ataxia and frequent attacks of lightning pains in the extremities. There had been one miscarriage. Otherwise the history was not significant.

Examination revealed an inversion deformity of the left lower extremity with 1½ inches of shortening. The greater trochanter was above Nélaton's line. External rotation and abduction of the left hip could not be performed because of a bony block,



Figs. 1 and 2. Fig. 1 (left) shows the hip after reduction following the patient's first admission. Fig. 2 (right) shows extensive ossification of the joint capsule, eight months later.

zation of the joint. While this condition has been described frequently in the literature, very few roentgenograms have been presented showing the disease before extensive destruction has occurred. Ferguson (1) shows a film of a very early Charcot knee revealing some detritus in the joint and slight bony condensation. In the case described below no roentgenologically demonstrable destructive changes in the bone were present at the initial observation.

G. B., a white female 57 years old, was admitted to Michael Reese Hospital, Chicago, on July 13, 1936. She stated that four weeks previously she had suddenly suffered a dizzy spell and had fallen,

but muscle spasm, pain, and tenderness were absent despite marked swelling and ecchymosis in the left groin. The telescoping phenomenon was easily elicited.

The pupils were unequal in size and non-reactive to light. The knee and ankle reflexes were absent. Position sense was absent in the toes. The upper extremities showed no motor or sensory disturbances.

The general examination was negative except for moderate emaciation.

The blood Wassermann reaction was negative, but the Kahn reaction was 3 plus. Roentgenograms made on the date of admission revealed a dislocation of the left hip, but there was no apparent involvement of the articular surfaces.

The following day reduction was easily accomplished, without anesthesia, by gentle traction on the flexed hip, followed by abduction and external rota-

<sup>1</sup> Accepted for publication in July 1943.



Fig. 3. Roentgenogram made Aug. 31, 1937, showing complete disruption of the architecture of the femoral head and a portion of the neck.

tion. Figure 1 shows the hip reduced, the radiological picture being that of a normal joint.

A spica cast was applied. Six weeks later the cast was bivalved and the patient went home, Aug. 23, 1936, wearing a posterior shell. She returned to the hospital six days later, stating that she had got out of her cast and tried to walk, and her hip had again "slipped out of place." General anesthesia with ethylene and ether was required for reduction of this recurrent dislocation. A cast was again applied and was worn for three weeks; it was replaced by a brace which prevented hip rotation but allowed flexion and extension. The brace was worn for six months. On March 24, 1937, the roentgenogram (Fig. 2) revealed normal position of the femoral head, with good articular space, but ex-

tensive ossification of the joint capsule. The patient then declined to wear her brace any longer. She was not seen again till Aug. 30, 1937, when she stated that four days previously her hip had spontaneously "slipped out" again. She had an eversion deformity with  $1\frac{1}{2}$  inches of shortening, and roentgenographic examination (Fig. 3) made at Michael Reese Hospital was reported as follows: "There is complete disruption of the architecture of the femoral head and a portion of the neck. A small fragment of head still remains present in the acetabular fossa. Scattered about it, and far above and below the joint, there are numerous fragments of newly formed bone which are distributed irregularly above and below the sharply demarcated base of the old femoral head. The proximal end of the femur at this sharply demarcated edge is dislocated superiorly and makes no contact with the acetabular fossa. The findings are those of a Charcot hip."

The patient refused further treatment.

#### COMMENT

The serial roentgenograms show the progress of this case of tabetic arthropathy. This is the only case as far as the writer can determine in which films are presented showing a Charcot joint in so early a stage. Whitman's (2) statement that the disease is sometimes caused directly by injury but that the predisposing cause is the loss of protection due to the hypotonicity of the muscles is apparently well verified in this instance.

#### REFERENCES

1. FERGUSON, ALBERT B.: Roentgen Diagnosis of the Extremities and Spine. *Annals of Roentgenology*, Vol. XVII, New York, Paul B. Hoeber, Inc., 1939, p. 276.
2. WHITMAN, ROYAL: A Treatise on Orthopaedic Surgery. Philadelphia, Lea & Febiger, 8th ed., 1927, p. 304.

# EDITORIAL

Howard P. Doub, M.D., Editor

John D. Camp, M.D., Associate Editor

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## Eldwin Roy Witwer, M.D.

It is a trite saying that the honor should seek the man, not the man the honor. In the elevation of Dr. Eldwin Roy Witwer to the presidency of the Radiological Society of North America there can be no doubt that the man was chosen for the honor. Inasmuch as this office carries with it not only honor but responsibility and hard work, the selection of Doctor Witwer is especially fortunate, as he is singularly well equipped for the position by training and natural endowments. The executives of the Society who have worked with him in committee know of his genius for organization and management, as well as his untiring zeal. They have seen the excellent scientific exhibits produced during his five years as chairman of the committee having that matter in charge. A proper appreciation of his accomplishments, however, can be had only by those who have seen him in his daily activities during years of association.

Doctor Witwer has become an important fixture in the Detroit Roentgen Ray and Radium Society. A past president, he has been re-elected secretary-treasurer for fifteen years. This annual draft is a tribute to his ability and willingness to serve with no thought but the need of doing the job. He has been an important cog in the affairs of local and state medical organizations and is at present secretary of the Wayne County Medical Society and a counsellor of the Michigan State Medical Society. Among his numerous duties has been service on legislative and hospitalization committees and as liaison agent between lay and military organizations. Of exceptional merit is his work as chairman of

the Wayne County Medical Society program committee, which has produced excellent programs with outstanding speakers.

Eldwin Roy Witwer was born in Huron County, Ontario, Aug. 23, 1890. His family early moved to Michigan, where he was educated in the public schools. For premedical training he attended Valparaiso University, and in 1914 received the degree of Doctor of Medicine from the Detroit College of Medicine and Surgery, now Wayne University.

After his graduation, Doctor Witwer went to Harper Hospital in Detroit, spending several years in the pathology laboratory of Dr. Plinn F. Morse. In 1920, after a course of special study in Cook County Hospital, he entered upon his radiological career as roentgenologist to the Charles Godwin Jennings Hospital in Detroit. In 1927 he became associated with the firm of Dr. Wm. A. Evans and Dr. Lawrence Reynolds in the practice of radiology, and now occupies the positions of radiologist at Harper Hospital, attending radiologist at Cottage Hospital and Marine Hospital, and consulting radiologist to Charles Godwin Jennings Hospital and Children's Free Hospital.

Doctor Witwer has contributed numerous articles to the literature of radiology and has made frequent presentations and participated in many discussions at society meetings. Though his professional activities have been unusually great, he has found time for furtherance of fellowship and has gone through the chairs of the Blue Lodge of Masonry and attained his 32nd degree.





ELDWIN R. WITWER, M.D.  
President of the Radiological Society of North America

His chief hobby is farming, in which he shows a proficiency comparable to his medical skill. His registered Percherons are his pride and joy, and he combines the instinct of the traditional pioneer farmer with the latest ideas in modernization. Outings at the Witwer farm and the hos-

pitality of the Doctor and his charming wife are memorable to many Detroiters.

The Radiological Society of North America could not have made a more happy choice of leader during this trying war year. Doctor Witwer's many friends join in wishing him all possible success.

E. WALTER HALL, M.D.

## The Cumulative Index

The progress of scientific medicine in North America has been called one of the phenomena of this as well as the last century. Today the world recognizes this progress in many ways, by increasing references to American medical publications, by increasing numbers of exchange professorships and scholarships, and above all by an increasing regard for American medical research. The Director of the Medical Department of the British Council, Dr. N. H. Jones, recently wrote of "the considerable respect that many of us here have, not only for American medical literature, but for the remarkable lead that America has given to the rest of the world in everything pertaining to medical bibliography and medical librarianship."

It is therefore quite timely to notice the publication of our own Society's Cumulative Index, an index covering volumes 1 to 39 of RADIOLOGY, for the years 1923-1942.

The material covered by the Index embraces the entire field of x-ray and radium, through original articles as well as abstracts from a wide variety of journals, both foreign and domestic. A highly informative introduction is followed by almost 400 pages of text. Authors and subjects are listed in simple alphabetical order in a

single index. Numerous subheadings and cross references are employed. References include original papers, case reports, abstracts, obituaries, book reviews, meetings and reports of the Radiological Society, Bulletins of the American College of Radiology, and miscellaneous items of scientific interest which have appeared in the pages of RADIOLOGY.

The actual style of the entries is in accord with that used by the *Quarterly Cumulative Index Medicus*, than which there is probably none better. The format is similar to that of RADIOLOGY, and the thickness equivalent to about two and one-half issues of the monthly journal.

In everyday work, in consultation practice and, above all, in preparing manuscripts, the value of a good cumulative index is beyond description. The Society is to be congratulated on completing the good work, and the Editor and his staff complimented on getting it out, despite the distractions of war and the difficulties of present-day publication. This "rich storehouse of radiological information" will soon be in every medical library and, probably, in most radiologists' offices. It is to be hoped that the demand will not exceed the supply available.

L. HENRY GARLAND, M.D.



ELDWIN R. WITWER, M.D.  
President of the Radiological Society of North America

# RADIOLOGICAL SOCIETY OF NORTH AMERICA

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## TWENTY-NINTH ANNUAL MEETING, CHICAGO

Dec. 1-Dec. 2, 1943

The Twenty-Ninth Annual Meeting of the Radiological Society of North America, held at the Drake Hotel, Chicago, Dec. 1 and 2, 1943, was limited to executive sessions, the scientific sessions, refresher courses, and exhibitions having been canceled at the request of the Office of Defense Transportation.

The meeting convened Wednesday morning, Dec. 1, 1943, when the official gavel was presented to Dr. Robert S. Stone, President, by Dr. Lewis G. Allen, Chairman of the Board of Directors. Doctor Stone responded and expressed the regret of the officers that the usual type of meeting had been canceled because of the patriotic desire to help alleviate the travel and hotel situation.

Doctor Stone then reported that prior to the cancellation of the scientific sessions he had arranged an excellent program and that the papers would be read by title. They thus became the property of the Society and would be published in *RADIOLOGY*, where all members would have the opportunity of reading them; the various essayists had been notified of this procedure and the papers were now due at the Editorial Office.

A quorum being present, an executive session was held and the usual business of the Society was transacted. Reports of the officers were presented and approved. These will subsequently be published

and copies sent to the members. The following officers were nominated and unanimously elected:

President: Eldwin R. Witwer, M.D.

President-Elect: Lewis G. Allen, M.D.

1st Vice-President: Edgar P. McNamee, M.D.

2d Vice-President: Heddy S. Shoulders, M.D.

3d Vice-President: Zoe A. Johnston, M.D.

Secretary-Treasurer: Donald S. Childs, M.D.

Librarian: Howard P. Doub, M.D.

Member of Board of Directors: Davis Spangler, M.D.

In the evening the customary banquet was held and, while the attendance was small as compared to former years, the spirit of good fellowship was undiminished. Doctor Stone's presidential address was timely and interesting. It is hoped that it may be published later so that all may enjoy it. It was announced that honorary membership had been conferred on Dr. Charles G. Sutherland and that his Diploma had been sent to him. The newly elected officers were introduced and the Pfahler gavel was presented by Doctor Stone to the new president, Dr. Eldwin R. Witwer. In his response Doctor Witwer pledged that every effort would be made to arrange a meeting for next year unless the war situation is such that it is not feasible.



# RADIOLOGICAL SOCIETIES OF NORTH AMERICA

*Editor's Note.*—Will secretaries of societies please cooperate by sending information to Howard P. Doub, M.D., Editor, Henry Ford Hospital, Detroit 2, Mich.

## UNITED STATES

*Radiological Society of North America.*—Secretary, D. S. Childs, M.D., 607 Medical Arts Building, Syracuse, N. Y.

*American Roentgen Ray Society.*—Secretary, Harold Dabney Kerr, M.D., Iowa City, Iowa.

*American College of Radiology.*—Secretary, Mac F. Cahal, 540 N. Michigan Ave., Chicago, Ill.

*Section on Radiology, American Medical Association.*—Secretary, J. T. Murphy, M.D., 421 Michigan St., Toledo, Ohio.

## ARKANSAS

*Arkansas Radiological Society.*—Secretary-Treasurer, J. S. Wilson, M.D., Monticello. Meets every three months and annually at meeting of State Medical Society.

## CALIFORNIA

*California Medical Association, Section on Radiology.*—Secretary, Earl R. Miller, M.D., University of California Hospital, San Francisco, Calif.

*Los Angeles County Medical Association, Radiological Section.*—Secretary, Donald R. Laing, M.D., 65 N. Madison Ave., Pasadena. Meets second Wednesday of each month at County Society Building.

*Pacific Roentgen Society.*—Secretary-Treasurer, L. Henry Garland, M.D., 450 Sutter St., San Francisco. Society meets annually during annual meeting of the California Medical Association.

*San Francisco Radiological Society.*—Secretary, Sydney F. Thomas, M.D., San Francisco Hospital. Meets monthly on third Thursday at 7:45 p.m., in Toland Hall, University of California Hospital.

## COLORADO

*Denver Radiological Club.*—Secretary, Edward J. Meister, M.D., 366 Metropolitan Bldg. Meetings third Friday of each month at the Denver Athletic Club.

## CONNECTICUT

*Connecticut State Medical Society, Section on Radiology.*—Secretary-Treasurer, Max Climan, M.D., 242 Trumbull St., Hartford. Meetings bimonthly, on second Thursday. Place of meeting selected by Secretary.

## FLORIDA

*Florida Radiological Society.*—Acting Secretary, Walter A. Weed, M.D., 204 Exchange Building, Orlando.

## GEORGIA

*Georgia Radiological Society.*—Secretary-Treasurer, James J. Clark, M.D., 478 Peachtree St., N. E., Atlanta. Meetings twice annually, in November and at the annual meeting of State Medical Association.

## ILLINOIS

*Chicago Roentgen Society.*—Secretary, Warren W. Furey, M.D., 6844 S. Oglesby Ave. Meets at the Palmer House, second Thursday of October, November, January, February, March, and April.

*Illinois Radiological Society.*—Secretary-Treasurer, William DeHollander, M.D., St. Johns' Hospital, Springfield. Meetings quarterly by announcement.

*Illinois State Medical Society, Section on Radiology.*—Secretary, Fay H. Squire, M.D., 1753 W. Congress St., Chicago.

## INDIANA

*The Indiana Roentgen Society.*—Secretary-Treasurer, Harold C. Ochsner, M.D., Methodist Hospital, Indianapolis. Annual meeting in May.

## IOWA

*The Iowa X-ray Club.*—Holds luncheon and business meeting during annual session of Iowa State Medical Society.

## KENTUCKY

*Kentucky Radiological Society.*—Secretary-Treasurer, Sydney E. Johnson, M.D., Louisville City Hospital, Louisville. Meeting annually in Louisville, third Saturday afternoon in April.

## LOUISIANA

*Louisiana Radiological Society.*—Secretary-Treasurer, Johnson R. Anderson, M.D., North Louisiana Sanitarium, Shreveport. Meets annually at same time as State Medical Society.

*Shreveport Radiological Club.*—Secretary-Treasurer, R. W. Cooper, 940 Margaret Place. Meetings monthly on the second Wednesday, at the offices of the various members.

## MARYLAND

*Baltimore City Medical Society, Radiological Section.*—Secretary, Walter L. Kilby, M.D., 101 W. Read St. Meetings are held the third Tuesday of each month.

## MICHIGAN

*Detroit X-ray and Radium Society.*—Secretary-Treasurer, E. R. Witwer, M.D., Harper Hospital, Detroit. Meetings first Thursday of each month from October to May, inclusive, at Wayne County Medical Society club rooms, 4421 Woodward Ave., Detroit.

*Michigan Association of Roentgenologists.*—Secretary-Treasurer, E. M. Shebesta, M.D., 1429 David Whitney Bldg., Detroit. Meetings quarterly by announcement.

## MINNESOTA

*Minnesota Radiological Society.*—Secretary, John P. Medelman, M.D., 572 Lowry Medical Arts Bldg., St. Paul. Meetings quarterly.

## MISSOURI

*Radiological Society of Greater Kansas City.*—Secretary, Arthur B. Smith, M.D., 306 E. 12th St., Kansas City, Mo. Meetings last Thursday of each month.

*The St. Louis Society of Radiologists.*—Secretary, Paul C. Schnoebelen, M.D., 462 N. Taylor Ave. Meets on fourth Wednesday of each month except June, July, August, and September, at a place designated by the president.

## NEBRASKA

*Nebraska Radiological Society.*—Secretary, F. L. Simonds, M.D., 1216 Medical Arts Bldg., Omaha. Meetings third Wednesday of each month at 6 p.m. in either Omaha or Lincoln.

## NEW ENGLAND

*New England Roentgen Ray Society* (Maine, New Hampshire, Vermont, Massachusetts, and Rhode Island).—Secretary, Hugh F. Hare, M.D., Lahey Clinic, Boston, Mass. Meets monthly on third Friday at Boston Medical Library.

## NEW JERSEY

*Radiological Society of New Jersey.*—Secretary, H. J. Perlberg, M.D., Trust Co. of New Jersey Bldg., Jersey City. Meetings at Atlantic City at time of State Medical Society and midwinter in Newark as called by president.

## NEW YORK

*Associated Radiologists of New York, Inc.*—Secretary, William J. Francis, M.D., 210 Fifth Ave., New York City. Regular meetings the first Monday evening of the month in March, May, October, and December.

*Brooklyn Roentgen Ray Society.*—Secretary-Treasurer, Leo Harrington, M.D., 880 Ocean Ave. Meetings held the fourth Tuesday of every month, October to April.

*Buffalo Radiological Society.*—Secretary-Treasurer, Joseph S. Gianfranceschi, M.D., 610 Niagara St. Meetings second Monday evening each month, October to May, inclusive.

*Central New York Roentgen Ray Society.*—Secretary-Treasurer, Carlton F. Potter, M.D., 425 Waverly Ave., Syracuse. Meetings are held in January, May, and October, as called by Executive Committee.

*Long Island Radiological Society.*—Secretary, Marcus Wiener, M.D., 1430 48th St., Brooklyn. Meetings fourth Thursday evening each month at Kings County Medical Bldg.

*New York Roentgen Society.*—Secretary, Haig H. Kasabach, Presbyterian Hospital, New York, N. Y.

*Rochester Roentgen-ray Society.*—Secretary, S. C. Davidson, M.D., 277 Alexander St. Meetings at convenience of committee.

## NORTH CAROLINA

*Radiological Society of North Carolina.*—Secretary-Treasurer, Major I. Fleming, M.D., 404 Falls Road, Rocky Mount. Meeting with State meeting in May, and meeting in October.

## NORTH DAKOTA

*North Dakota Radiological Society.*—Secretary, L. A. Nash, M.D., St. John's Hospital, Fargo. Meetings by announcement.

## OHIO

*Ohio Radiological Society.*—Secretary, J. E. McCarthy, M.D., 707 Race St., Cincinnati. The next meeting will be held at the time and place of the annual meeting of the Ohio State Medical Association.

*Cleveland Radiological Society.*—Secretary-Treasurer, Don D. Brannan, M.D., 11311 Shaker Blvd., Cleveland 4. Meetings at 6:30 P.M. on fourth Monday of each month from October to April, inclusive.

*Radiological Society of the Academy of Medicine (Cincinnati Roentgenologists).*—Secretary-Treasurer, Samuel Brown, M.D., 707 Race St. Meetings held third Tuesday of each month.

## PENNSYLVANIA

*Pennsylvania Radiological Society.*—Secretary-Treasurer, L. E. Wurster, M.D., 416 Pine St., Williamsport. The Society meets annually.

*The Philadelphia Roentgen Ray Society.*—Secretary, Robert P. Barden, M.D., 3400 Spruce St., Philadelphia. Meetings held first Thursday of each month at 8:15 P.M., from October to May, in Thomson Hall, College of Physicians, 21 S. 22nd St., Philadelphia.

*The Pittsburgh Roentgen Society.*—Secretary-Treasurer, Reuben G. Alley, M.D., 4800 Friendship Ave., Pittsburgh, Pa. Meetings are held on the second Wednesday of each month at 4:30 P.M., from October to June, at the Pittsburgh Academy of Medicine, 322 N. Craig St.

## ROCKY MOUNTAIN STATES

*Rocky Mountain Radiological Society* (North Dakota, South Dakota, Nebraska, Kansas, Texas, Wyoming, Montana, Colorado, Idaho, Utah, New Mexico).—Secretary, A. M. Popma, M.D., 220 North First St., Boise, Idaho.

## SOUTH CAROLINA

*South Carolina X-ray Society.*—Secretary-Treasurer, Robert B. Taft, M.D., 103 Rutledge Ave., Charleston. Meeting in Charleston on first Thursday in November, also at time and place of South Carolina State Medical Association.

## TENNESSEE

*Memphis Roentgen Club.*—Chairmanship rotates monthly in alphabetical order. Meetings second Tuesday of each month at University Center.

*Tennessee Radiological Society.*—Secretary-Treasurer, J. Marsh Frère, M.D., 707 Walnut St., Chattanooga. Meeting annually with State Medical Society in April.

## TEXAS

*Texas Radiological Society.*—Secretary-Treasurer, Herman Klapproth M.D., Sherman.

## VIRGINIA

*Virginia Radiological Society.*—Secretary, E. Latané Flanagan, M.D., 215 Medical Arts Bldg., Richmond.

## WASHINGTON

*Washington State Radiological Society.*—Secretary-Treasurer, Thomas Carlile, M.D., 1115 Terry Ave., Seattle. Meetings fourth Monday of each month, October through May, at College Club, Seattle.

## WISCONSIN

*Milwaukee Roentgen Ray Society.*—Secretary-Treasurer, C. A. H. Fortier, M.D., 231 W. Wisconsin Ave., Milwaukee. Meets monthly on second Monday at the University Club.

*Radiological Section of the Wisconsin State Medical Society.*—Secretary, Russell F. Wilson, M.D., Beloit Municipal Hospital, Beloit. Two-day annual meeting in May and one day in connection with annual meeting of State Medical Society, in September.

*University of Wisconsin Radiological Conference.*—Secretary, E. A. Pohle, M.D., 1300 University Ave., Madison, Wis. Meets every Thursday from 4 to 5 P.M., Room 301, Service Memorial Institute.

## CANADA

*Canadian Association of Radiologists.*—Honorary Secretary-Treasurer, A. D. Irvine, M.D., 540 Tegler Bldg., Edmonton, Alberta.

*La Société Canadienne-Française d'Électrologie et de Radiologie Médicales.*—General Secretary, Origène Dufresne, M.D., Institut du Radium, Montreal. Meetings are held the third Saturday of each month, generally at the Radium Institute, 4120 East Ontario Street, Montreal; sometimes, at homes of members.

## CUBA

*Sociedad de Radiología y Fisioterapia de Cuba.*—Offices in Hospital Mercedes, Havana. Meetings are held monthly.

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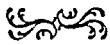
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# ROENTGEN DIAGNOSIS

## THE HEAD AND NECK

**Contrast Media in Lesions of the Cerebral Hemisphere.** Edgar A. Kahn. *Proc. Roy. Soc. Med.* 36: 403-405, June 1943.

The author, a major in the Army of the United States, recommends thorotrast for the localization of cystic brain lesions and encapsulated brain abscesses. It is non-irritating in closed cavities, mixes readily with fluid contents, and is phagocytized by the cellular elements of the abscess wall, rendering it radiopaque. Since only a small quantity of the contrast medium is required and this is largely removed at the time of evacuation of the cavity, there can be no injurious radioactive effects. Short histories of 6 cases in which thorotrast was used are included: an otogenic abscess; abscess below a drained subdural abscess; cystic glioblastoma multiforme; cystic astrocytoma. In this last case a mural nodule was demonstrable.

As a means of preventing cortico-meningeal adhesions, the author suggests the instillation of air between the cerebral cortex and dura. He cites two cases in which this procedure was followed. It is his opinion that it will be useful in acute cranio-cerebral war injuries, following débridement with removal of potentially infected bone and damaged brain tissue, and his hope that it will reduce the morbidity of such injuries.

HENRY K. TAYLOR, M.D.

## THE CHEST

**Value of Miniature Chest Films.** Arthur S. Webb. *Illinois M. J.* 83: 412-413, June 1943.

As a means of detecting possible chest lesions, the author has found stereofluoroscopic examination with 4 × 10-in. films almost 100 per cent accurate. His studies include over 4,000 films, of which 2,800 were 4 × 5 in., 1,000 4 × 10 in., and 850 14 × 17 in. Minimal lesions discovered on 14 × 17-in. films were invariably examined on the 4 × 10-in. films and were invariably demonstrated, with adequate detail to dictate further study, on at least one of the stereoscopic pair.

The author is not a roentgenologist but a tuberculosis worker and as such is particularly interested in the cost of chest surveys. While the 4 × 5-in. films are twice as expensive as the 4 × 10-in. film when there is greater accuracy of the former warrants the extra cost. Re-examination is done on 14 × 17-in. film when there is a question of interpretation or when a diagnosis is to be made because of the discovery of a possible lesion.

HENRY K. TAYLOR, M.D.

**Critical and Casuistic Contribution on the Theme "Fluoroscopy in the Army."** H. H. Weber. *Schweiz. med. Wchnschr.* 73: 793-796, June 19, 1943.

This is a critical discussion of the disadvantages of mass fluoroscopy as a tuberculosis case-finding method, covering many phases of the subject, from inaccuracies and poor definition of the screen to the inadvisability of having several hundred recruits cough in the examiner's face while he looks for cavities. While it is a competent review, it contains little new material.

LEWIS G. JACOBS, M.D.

**Results of Systematic Fluoroscopy of an Army Unit on Relief from Service.** C. Frei. *Schweiz. med. Wchnschr.* 73: 778-782, June 12, 1943.

This is an account of the fluoroscopic examination of men about to be discharged from army service. Abnormal findings were considered an indication for roentgenographic study, clinical investigation, and determination of sedimentation rates.

Of 6,369 discharges, 6,283 were studied fluoroscopically. In 55, pathological findings were obtained:

Active pulmonary tuberculosis.....	20
Old, inactive pulmonary tuberculosis.....	6
Eosinophilic lung infiltrates.....	13
Other pulmonary infiltrates.....	8
Bronchopneumonia.....	3
Peribronchitis.....	1
Pulmonary silicosis.....	3
Pathological cardiac findings.....	1

While this demonstrates that breakdowns from tuberculosis are now fewer than before those infected were weeded out, periodic fluoroscopy of troops would seem advisable to eliminate new cases of tuberculosis as they develop.

LEWIS G. JACOBS, M.D.

**Considerations on One Thousand Chest X-Ray Examinations Performed on Men Applying for Employment.** A. A. Bauer. *Illinois M. J.* 83: 415-417, June 1943.

Six hundred pre-employment chest roentgenograms of men between 18 and 45, seeking employment in industries entailing exposure to silica dust, were analyzed and catalogued as follows:

1. Healthy chest: 522 cases. This group presented no evidence of silicosis or active pulmonary lesions. It included calcified hilum nodes and primary foci; healed residuals of previous inflammatory, surgical, or traumatic processes; slight to moderate cardiac enlargement, slight widening of the aorta, and slight prominence of the aortic knob. Clinical and physical findings were negative.

2. Minimal grade silicosis: 22 cases.

3. Moderately advanced silicosis: 1 case.

4. Far advanced silicosis: None.

5. Pulmonary tuberculosis: 15 cases (5 minimal; 9 moderately advanced; 1 far advanced).

6. Tuberculosis and silicosis: None.

7. Special findings, not included above: 40 cases (cardiac enlargement; bronchitis and bronchiectasis; pleural effusion; wide aortic arch; prominent aortic knob; calcification of aorta; pulmonary fibrosis without beading; coarctation of aorta; pneumothorax dermoid cyst).

Many of the men were applying for industrial work for the first time, and the observations are believed to give a fair index of findings among a group without complaints referable to the chest. The high percentage of healthy chests is of interest.

HENRY K. TAYLOR, M.D.

**Miliary Calcification of the Lung.** Erving F. Geever. *Am. J. Roentgenol.* 49: 777-782, June 1943.

Miliary calcification of the lung is rather frequently encountered in routine chest surveys and has been

generally considered to be the result of tuberculosis. Several authors, however, have raised the question of other etiologic factors, including *Aspergillus* and *Ascaris*. In none of the previous reports have pathological studies been made. In the present report two typical examples of this condition are described, in both of which complete autopsy examinations were performed, the patients having died of entirely unrelated diseases. Detailed reports of the pathological studies are given. It is the author's opinion that the diagnosis in each instance was a healed miliary tuberculosis of the primary type. This interpretation was made on the basis of the close resemblance of the lesion to healed Ghon tubercles and because of the extensive hilar lymph node involvement. The infection had occurred many years previously, probably in infancy or childhood, and had completely healed. Although the possibility exists that other agents may cause this type of miliary calcification, the importance of tuberculosis should not be minimized.

L. W. PAUL, M.D.

**Loeffler's Syndrome.** James H. Smith. *South. M. J.* 36: 269-271, April 1943.

A case of migratory pulmonary infiltrations associated with eosinophilia is presented. Loeffler had observed 51 such cases by 1936 and emphasized the benign character of the entire course of the disease in contrast to the striking and sometimes alarming objective signs.

In the author's patient, a 55-year-old white woman, the chief findings were severe bronchitis and slight asthma. She was undernourished and was troubled by a persistent cough. At various intervals from June 1941 to April 1942 she was found to have a leukocytosis averaging about 16,000 and reaching 21,000, with an eosinophilia up to 70 per cent, averaging about 35 per cent. These abnormal values showed a rather steady return to normal. At intervals a low-grade afternoon temperature elevation was recorded, reaching about 100° F. Extensive skin tests were negative except for sensitivity to vaccines made from respiratory organisms. Serial chest roentgenograms showed massive exudative right pleuropulmonary involvement with rather rapid resolution, followed by the appearance of new lesions. Within six weeks there remained only moderate basal pleural thickening and in five months the chest was normal. Although asthmatic symptoms were minimal at the time of the massive pleuropneumonic process, the patient since has had severe asthmatic symptoms. An infected maxillary antrum did not respond to treatment. It is believed that this syndrome is probably a response to some allergin. Tuberculin, pollens, and respiratory organisms are suggested as inciting agents. MAX MASS, M.D.

**Discussion on Atypical Pneumonia.** John W. Brown *et al.* *Proc. Roy. Soc. Med.* 36: 385-390, June 1943.

Captain Brown of the Medical Corps of the Army of the United States opened this discussion with a general review of the subject of atypical pneumonia, referring briefly to his observations in an Army hospital in England, where 102 of 143 cases of pneumonia were of the atypical variety.

Lieut. Colonel Gordon E. Hein, also of the Army of the United States, reported that during an eight-

month period approximately 100 American soldiers in England had been treated in his hospital for atypical pneumonia. The cases differed in no essential way from cases observed in the United States, but it was not certain whether the disease process was the same in all or whether the etiological factor was identical. These cases differed both from the bacterial pneumonias and from the influenza of World War I, and they did not resemble the classical psittacosis.

Dr. Philip Ellman assumed that the designation "atypical pneumonia" referred to the non-stereotyped pneumonias, as opposed to the stereotyped form of lobar or bronchopneumonia, and his discussion, therefore, was not on the same subject.

Dr. H. Jules mentioned that, of 57 pneumonias seen in a three-month period at the Central Middlesex County Hospital, 12 were of the atypical variety.

HENRY K. TAYLOR, M.D.

**Bagasse Disease of the Lung.** W. A. Sodeman and Roscoe L. Pullen. *New Orleans M. & S. J.* 95: 558-560, June 1943.

A 26-year-old white male who had been working in bagasse dust for twenty weeks complained of shortness of breath and cough. Roentgen examination showed "a miliary ground glass mottling throughout both lung fields, radiating from the hilar regions." Biopsy done during the sixth week of illness yielded pulmonary tissue in which were embedded several "spicules" of an irregular foreign material, similar microscopically to bagasse. Under the polarizing microscope these "spicules" were seen to rotate polarized light. Many smaller scattered pieces, with an average size of  $2 \times 8$  microns were also found, especially where there was a fibroblastic reaction of the interstitial tissue of the lung.

The authors also describe the microscopic findings in the lung in a case of bagasse disease coming to autopsy. Fundamentally the same type of reaction was present.

The conclusion is reached that the particles of bagasse in the lungs are responsible for an organic pneumoconiosis.

HENRY K. TAYLOR, M.D.

**Nontuberculous Empyema Thoracis in Children.** J. K. Berman. *Surg., Gynec. & Obst.* 76: 183-188, February 1943.

A study of 184 cases of empyema thoracis before and since the use of the sulfonamides is reported. The author states that rib resection with open drainage is the method of choice in the treatment of empyema thoracis in children. Since the advent of the sulfonamide drugs, fluoroscopic examination is necessary to determine the proper time for this procedure. Formerly the proper time for drainage was based upon the consistency of the pus obtained by aspiration. However, the pus may be thick very early in the disease when sulfonamides have been used, and this change in consistency may precede localization.

The fluoroscope is important to determine (1) whether or not localization has occurred and (2) the position of the encapsulated and interlobar varieties of empyema. The method is based upon the fact that with localization comes fixation of the walls of the empyema cavity. In children empyemas are usually massive, so that fixation of the movable diaphragm and mediastinum are accurate guides. The mediastinum

does not change so much in adults. Even in localized cavities, however, the phenomenon of fixation of the surrounding lung can be demonstrated.

In the child with empyema a thoracentesis is done to determine the type of organism, partially to empty the cavity of pus, and also to inject air. First, the child is observed in the upright position. The fluid level is easily seen and before localization moves with respiration. It descends with the diaphragm on inspiration and ascends on expiration. After localization two phenomena have been observed: (a) no movement—seen in bilateral and sometimes unilateral empyema; (b) paradoxical movement—seen in unilateral empyema due to an exaggerated movement of the opposite leaf of the diaphragm.

It is impossible to observe the movement of the diaphragm with the patient in the flat or upright position, because pus obscures the contour of the diaphragm and on the right side the liver also adds its dense shadow, making such observation difficult. With the patient tilted in the head-down (Trendelenburg) position the diaphragm can be seen easily if a sufficient amount of air is present in the empyema cavity (small amounts of air seen in the costophrenic angle only are of no aid); 20 to 30 c.c. of pus or more are aspirated and an equal amount of air is injected. Fixation of the diaphragm implies localization.

A third maneuver is employed to observe the mediastinum. The patient is turned on the affected side and is observed in the anteroposterior (lateral decubitus) plane. The pus gravitates away from the mediastinum, permitting observation of its movements. If it is fixed, the cavity is completely localized and open drainage may be safely done.

The author adds some observations as to the effect of the sulfonamides on the course of the disease and the occurrence of complications.

**Xanthomatosis—Hand-Schüller-Christian Type:** Report of a Case with Pulmonary Fibrosis. James H. Currans and Walter C. Popp. *Am. J. M. Sc.* 205: 780-785, June 1943.

The presence of map-like defects of the skull, exophthalmos, and signs of hypopituitarism are not necessary for the conclusive diagnosis of Hand-Schüller-Christian disease. Involvement may occur in any part of the reticulo-endothelial system, resulting in such clinical signs as lymphadenopathy, pulmonary fibrosis, hyperpyrexia, hepatomegaly and splenomegaly, involvement of the long bones, and icterus. The etiology remains obscure; it is thought to lie in a disturbance in the metabolism of cholesterol and cholesterol esters. Some pathologists, however, believe that the disease may be an infectious type of granuloma.

A 29-year-old woman had intermittent twinges of pain over the right parietal region, followed in six months by a palpable swelling at that site and the occurrence of dull aching pain in the left hip. A tender, soft, raised zone with discrete borders, about 6 cm. in diameter, was found in the right parietal region. Tenderness was elicited over the greater trochanter of the left femur; the motion of the left hip was limited because of pain. The laboratory studies, including those of cholesterol, cholesterol esters, fatty acids, and total lipoids, were normal.

Roentgenograms of the skull showed an irregular zone of bone destruction in the right parietal bone. A similar defect was seen in the neck of the left femur.

Extensive bilateral fibrosis was demonstrated in the chest film. Biopsy of the skull showed Hand-Schüller-Christian disease. The fat content of the biopsy specimen was low. The cyst-like areas in the skull and femur accounted for the symptoms, but the pulmonary fibrosis was unusual. The low fat content of the tissue suggested that the process was old. Because of the possibility that the pulmonary lesions might be granulomatous, irradiation therapy was given to the left lung, through an anterior and posterior portal. One treatment was given to the skull, and one to an anterior and posterior portal over the neck of the femur, using x-rays of 130 kv. Two additional courses of therapy were given at monthly intervals.

There was marked improvement of the skull and femur and slight improvement in the irradiated lung five months later. BENJAMIN COPLEMAN, M.D.

**Carcinoma of the Lung. A Review of 31 Proved Cases at the Philadelphia Naval Hospital.** Ferdinand Fetter. *Ann. Int. Med.* 18: 978-987, June 1943.

Thirty-one patients (veterans) with proved primary lung carcinoma were admitted to the Naval Hospital in Philadelphia from Jan. 1, 1941, to Oct. 1, 1942. Unfortunately, no symptoms or physical signs are pathognomonic of pulmonary cancer. Cough and sputum were present in all but one of the patients. In addition, chest pain, hemoptysis, loss of weight, and weakness were generally found.

In this series the most important finding on the x-ray film suggesting lung cancer was atelectasis distal to the tumor, with an accompanying shift of the mediastinum toward the affected side. This occurred in 65 per cent of the cases. A less common finding was the single circumscribed lesion usually peripheral and beyond the reach of the bronchoscope. This was present in 15 per cent of the series.

Numerous methods are available for establishing a diagnosis. The most valuable procedure is the bronchoscopic examination. Biopsies are taken if abnormal tissues are seen. Bronchoscopy was done in 25 of the author's 31 cases and positive bronchoscopic biopsies were obtained in 14 of these, or 45 per cent of the proved cases. The use of iodized oil is not so helpful as bronchoscopy. In a suspected case, however, it may show stenosis proximal to an area of atelectasis.

The presence of pleural fluid in lung cancer makes the case inoperable. If tumor cells are found in the pleural fluid, it signifies an extension of the tumor to the pleura. Aspiration biopsy of the lung is almost universally condemned as being too dangerous, due to the possibility of an air embolism.

In suspicious cases, if the patient is in reasonably good health with no evidence of metastasis, an exploratory thoracotomy should be done.

Those cases in which the diagnosis is established by a biopsy from a metastatic lesion are obviously inoperable.

Roentgen therapy should be used only as a palliative measure in inoperable cases to relieve such symptoms as pain and dyspnea. Surgical removal offers the only hope of cure. In the hands of experienced chest surgeons, the operative mortality has decreased from 33.3 to 16.6 per cent. Of the 31 patients in the author's series with a proved diagnosis, 6 were operated upon, but in none was surgical removal of the lesion possible. Roentgen therapy was employed in 16 inoperable cases, including 4 of those in which exploratory

thoracotomy had been done. In no case was a cure obtained, but in about half symptoms were relieved and the patient was more comfortable than before treatment.

The difficulty and delay in establishing a diagnosis plus the technical difficulties involved in the surgical removal of the involved lung make pulmonary carcinoma a highly fatal disease.

Several roentgenograms and a short bibliography are included.

STEPHEN N. TAGER, M.D.

**"Spring Water" Cyst of the Mediastinum: Case Report.** Irving Greenfield, Israel Steinberg, and Arthur S. W. Touroff. *J. Thoracic Surg.* 12: 495-502, June 1943.

In 1937 Churchill reported a case of a lobulated mass in the anterior mediastinum which proved to be a simple cyst lined with mesothelial cells, containing crystal-clear fluid. There were no structures by which it could be identified and Churchill called it a "spring water" cyst of the mediastinum.

The authors present a description of the second reported case of "spring water" cyst.

The patient was a forty-four-year-old woman who suddenly felt a severe constricting pain across the anterior portion of the upper chest. This gradually subsided but she continued to have heaviness sub-sternally and slight discomfort on swallowing solid foods. Roentgenograms of the chest showed a round, smooth mass in the anterosuperior mediastinum, more on the left side than the right. Angiocardiography established that the origin was not from the heart or great vessels. The mass was removed surgically and was a thin-walled cyst containing crystal-clear fluid. The lining of the cyst was columnar epithelium, which is distinctly unlike the mesothelial lining in Churchill's case. The roentgenograms pre- and post-operative, as well as the angiocardiograms, are reproduced in the article.

HAROLD O. PETERSON, M.D.

**Angiocardiography in Congenital Heart Disease: Intracardiac Shunts.** M. F. Steinberg, A. Grishman, and M. L. Sussman. *Am. J. Roentgenol.* 49: 766-776, June 1943.

Eighteen cases of intracardiac shunts secondary to congenital cardiovascular disease have been studied by means of angiocardiography and form the basis of this paper. These included 10 cases of interatrial septal defects, 2 of interventricular septal defects, and 6 of transposition of the great vessels, 4 of this last group showing the tetralogy of Fallot and 2 Eisenmenger's syndrome.

The value of angiocardiography in congenital cardiac septal defect depends upon the demonstration of a shunt between the right and left side of the heart, as well as the size of the cardiac chambers and great vessels. The method is of greatest value when a right to left shunt is present more or less constantly or, in other words, in the presence of cyanosis. Absence of cyanosis indicates that the pressure in the left heart is greater than in the right.

In the presence of interatrial septal defects the expected angiocardiographic pattern would include revisualization of the right auricle and ventricle after the opaque material had reached the left heart. This demonstration has not been achieved unequivocally

because of the dilution of the contrast medium. In the presence of interventricular septal defects, revisualization of the right ventricle after it has emptied is to be expected. In transposition of the great vessels there is simultaneous visualization of the right ventricle, aorta, pulmonary artery, and left ventricle within two to three seconds of the beginning of the injection, due to the passage of opaque material directly from the right ventricle into the aorta.

Accurate clinical diagnosis is possible in most cases of intracardiac shunt but confirmatory evidence of value may be obtained. Angiocardiography is of particular value in the Eisenmenger complex because with conventional roentgenography the large pulmonary artery may obscure the presence of a dextraposed aorta.

L. W. PAUL, M.D.

**Multiple Saccular Aneurysms of the Aorta with Roentgen and Necropsy Findings.** F. B. Mandeville. *Virginia M. Monthly* 70: 293-296, June 1943.

While it is generally known that small aneurysms of the cerebral arteries are commonly multiple, the fact that more than one aneurysm of the aorta may occur is often overlooked in clinical and roentgen examinations. A review of the literature shows that multiple aneurysms do occur, though infrequently, the causes including syphilis, trauma, atheroma, and bacterial infection.

A colored male, aged 26 years, complained of a bad cold with pain in the left side over the lower chest, a severe barking cough, the expectoration of thick, clear, tenacious sputum, and severe epistaxis. The blood pressure varied in the two arms. There was a slight fever. Physical examination revealed slight bilateral cervical and submaxillary lymphadenopathy, abnormal breath sounds, and an expiratory grunt. The aortic arch was widened. The blood Wassermann reaction was four plus. There was a slight leukocytosis and slight anemia.

Postero-anterior and left lateral views of the chest showed a somewhat irregularly lobulated mass in the mediastinum, extending to both sides about equally and pressing the trachea forward and to the right. There was a small amount of fluid in the left lower chest, the left dome of the diaphragm was a little higher than the right, and the heart was not enlarged. Fluoroscopy showed a lobulated mass in the mediastinum with a slight transmitted pulsation and a fluid level at the left base. All the findings suggested a lymphoblastoma with small left pleural effusion.

Roentgen therapy was administered to the mediastinum as a diagnostic test, 1,000 r being given in five days. Re-examination three, ten, and seventeen days later showed no appreciable change in the size or appearance of the mediastinum. No expansile pulsation was noted nor was there any other typical evidence of aneurysm, although it was considered.

At necropsy the aorta was found to be distended by three saccular aneurysms in the arch, 1 cm., 3.5 cm., and 10 cm. in diameter. The smallest bulged anteriorly to the left; the second, somewhat horn-shaped, bulged to the right posteriorly; the third, 10 cm. in diameter, extended toward the right, pushing the trachea and esophagus ahead of it. When the esophagus was dissected from the tip of the aneurysm, it was found that practically no wall was left and that at this point the aneurysm was covered by soft adventitial

tissue of the esophagus. The microscopic diagnosis was syphilitic aortitis.

Sir William Osler's dictum that there is no disease more conducive to clinical humility than aneurysm of the aorta appears to be confirmed. The author suggests that "roentgen humility" be substituted for "clinical humility" and the word "multiple" be placed in front of "aneurysm." J. E. WHITELEATHER, M.D.

## DIGESTIVE SYSTEM

**Congenital Atresia of the Esophagus with Tracheo-esophageal Fistula; Extrapleural Ligation of Fistula and End-to-End Anastomosis of Esophageal Segments.** Cameron Haight and Harry A. Towsley. Surg., Gynec. & Obst. 76: 672-688, June 1943.

In the last seven years there were seen in the University of Michigan Hospital 15 infants with congenital atresia of the esophagus. In 14 of these a tracheo-esophageal fistula was known to be present. In 9 intrathoracic exploration was done with the intention of establishing continuity of the esophagus. Ligation of the fistula and anastomosis of the esophageal segments were accomplished in 5 cases; a successful result was obtained in one case, and the patient was alive eleven and a half months after operation. After the original preparation of the report, 9 additional cases were seen, and extrapleural ligation of the fistula and end-to-end anastomosis of the esophageal segments were done in 8 patients. Four of these were still alive after periods ranging from one to nearly eight months.

A positive diagnosis of esophageal obstruction is made by roentgenologic examination with an opaque medium or by the inability to pass a catheter into the stomach. In the presence of complete esophageal obstruction, the occurrence of a tracheoesophageal fistula is indicated by tympany or distention of the upper abdomen on physical examination and by the roentgen demonstration of air in the stomach. Endoscopy may be employed to establish the type of anomaly, but the authors believe it is unnecessary, except possibly in those cases without air in the stomach.

Iodized oil is administered under fluoroscopic control to determine the level of obstruction of the upper esophageal segment. The retained oil should be removed with a catheter at the completion of the examination to avoid the danger of aspiration. Fluoroscopic examination furnishes a more accurate means of determining the length of the upper segment than does roentgenography. If one considers the possibility of operative correction from a study of the films alone, the fact that the upper segment occupies a high position, as seen in the roentgenogram, is not necessarily a contraindication to surgical reconstruction, since on fluoroscopic study this segment may descend as much as the height of two dorsal vertebrae. Failure to visualize air in the stomach suggests the absence of a tracheoesophageal fistula, but this is not necessarily the case. In 2 of the authors' 3 patients in whom air was not demonstrated in the stomach roentgenologically, a small communication was found between the trachea and a narrow lower esophagus at operation.

The surgical correction of esophageal atresia is not an emergency procedure, and the time of operation depends upon the general condition of the patient. Atelectasis and lobular pneumonia have been frequently associated pathological conditions. Associated congenital anomalies are also of frequent occur-

rence. Included in the authors' series were congenital stricture of the ureter, anomalous right subclavian artery, pancreatic cysts, talipes cavovagus, and fetal atelectasis.

The authors discuss the advantages of the various types of surgical procedure and also give in detail the technic followed in their successful case of esophageal reconstruction employing an extrapleural ligation of the fistula and end-to-end anastomosis. Postoperatively, roentgen examination with a portable unit should precede the administration of fluid by mouth. Fluoroscopy is deferred until the patient's condition warrants it. The chest should be examined roentgenographically the first several days after operation, to detect early atelectasis, bronchopneumonia, or pleural effusion.

DAVID KIRSH, M.D.

**Short Esophagus with Simple Peptic Ulceration.** P. R. Allison, A. S. Johnstone, and G. B. Royce. J. Thoracic Surg. 12: 432-457, June 1943.

The major part of this paper is made up of 10 case reports of short esophagus with peptic ulceration. All the patients were carefully studied roentgenographically and endoscopically, and reproductions of roentgenograms are included for each case. In many of the cases biopsy specimens were taken from above and below the cardiac sphincter, showing gastric mucosa on one side and esophageal mucosa on the other. A silver clip was attached to the mucosa at the junction of the two types of mucosa, and films were made to show the exact location of this junction.

Most of the patients are of middle age or older. They usually have pain half an hour to an hour after eating, located behind the sternum. Vomiting occurs sometimes, consisting usually in regurgitation of esophageal contents. Hematemesis may be profuse and even fatal. Dysphagia is the outstanding symptom and is probably of late occurrence in the natural history of the disease.

The diagnosis of a short esophagus depends on radiologic and endoscopic examinations. The chief roentgenographic finding is the difference in the mucosal pattern in the two areas. This is not always easy to determine, and the placing of a metal clip at the junction, as ascertained by biopsy, is the most accurate method of locating the end-point of the esophagus. The patients were examined with thick and thin barium in the supine, prone, and upright positions. In all cases there was a stricture of the esophagus beginning from 6 to 11 cm. above the diaphragm. An ulcer crater was not always demonstrable roentgenographically but some degree of ulceration, diffuse or localized, was evident endoscopically.

While it cannot be denied that a congenitally short esophagus does exist, the authors feel that in many of these cases the short esophagus is acquired secondary to scarring and contraction from the presence of esophageal inflammation and ulceration of long standing.

Treatment consisted chiefly of dilatation and ulcer diet, with fairly good palliative results but no complete cures.

HAROLD O. PETERSON, M.D.

**Medical Aspects of Hiatal Hernia.** Wm. H. Higgins. South. M. J. 36: 273-276, April 1943.

An analysis of 65 cases of diaphragmatic hiatal hernia shows a remarkably diverse symptomatology which often complicates diagnostic studies of the abdomen and thorax.

Although most hiatal hernias are congenital, they generally do not produce symptoms until after middle life. The age factors concerned are stretching of the hiatus, decrease in supportive tissues about the hiatal ring, decreased elasticity, and increased intra-abdominal tension. Obesity is an important contributory factor. The patients in the author's series usually presented a long history, with such erroneous diagnoses as cholecystitis, peptic ulcer, cardiac disease, pleurisy, intestinal obstruction, etc. The most difficult diagnostic problems were encountered in instances where pain was referred to the sternum, neck, shoulder, or arm, closely simulating an anginal attack. Dysphagia was the most common symptom. The upright position and walking often brought relief of pain. Hiccough and hematemesis were sometimes observed. Roentgen studies are indispensable in diagnosis. A small hernia, however, is not infrequently missed. Esophagoscopy is advised in cases which are not readily or adequately diagnosed roentgenologically. MAX MASS, M.D.

**Present Position of Gastroscopy in the Diagnosis of Gastric Disease.** Moses Paulson. *Am. J. M. Sc.* 205: 792-798, June 1943.

This article was written to point out when gastroscopy may or may not be indicated, and what may be expected from it. The flexible gastroscope came into being when it was learned that one could see through a curved tube if lenses of a very short focal distance were used. The instrument, which is 77 cm. long and 11 mm. in diameter, has an angle of deviation of 90 degrees and an angle of vision of 85 degrees.

In a comprehensive survey, a single death, ten perforations of the stomach, and one perforation of the jejunum in a resected stomach were reported in 22,951 examinations. Gastroscopy should not be attempted in aneurysms of the aorta or in strictures, cardiospasm, cancer, or varices of the esophagus. The examination is a matter of a few minutes and causes little discomfort. The ease of examination is such that the problem is not the insertion of the instrument but the orientation and interpretation of the examiner.

Gastroscopy has definite limitations. It visualizes the mucosa only. Biopsy specimens cannot be obtained, nor has photography been perfected. Small localized lesions may not be steadily seen due to changes in peristalsis and respiratory movements. Lesions of the lesser curvature, of the antrum and the upper third of the stomach are not always detectable. At times it may be difficult to distinguish between a benign and malignant lesion, or between cancer and hyperplastic gastritis. It is not what cannot be seen, but what can be seen that makes the instrument important.

Gastroscopy is in order whenever the roentgen-ray findings are negative and there is a persisting suspicion of some abnormality. As to the debate on how soon gastroscopy may be done following unexplained hematemesis or melena, the author's practice is to do it just as soon as the initial shock is over. Several types of gastritis have been described since the advent of the flexible gastroscope, but as yet there is no general agreement as to the extent to which gastritis may account for the complaints of these patients.

Not infrequently gross differentiation of benign from malignant lesions is made more correctly through the gastroscope than by roentgen ray, or at operation, or from the gross resected tissue, because the actual

living tissue without disturbed blood supply is seen. Gastroscopy is definitely indicated where the roentgen findings are not conclusive or where they are inconsistent in relation to the clinical picture. Recurrence of symptoms following operative procedures on the stomach is an indication for examination to ascertain the presence of gastritis or recurrence of an ulcer or cancer. Gastroscopy should be done in all patients in whom there is the slightest suspicion of gastric cancer. BENJAMIN COPELAND, M.D.

**Mistakes and Misunderstandings in the Roentgenologic Diagnosis of Gastric Cancer.** B. R. Kirklin. *Arch. Surg.* 46: 861-864, June 1943.

This paper, forming a part of a symposium on gastric cancer, discusses the errors, both real and imputed, in the roentgen diagnosis of gastric cancer. Failure to discover the lesion is the fault of the individual rather than the method, since any cancer capable of producing symptoms or visible macroscopically can be demonstrated. A certain number of errors are, of course, inevitable from human negligence, but fortunately these amount to less than 1 per cent of the cancers examined. Differentiation of malignant from benign lesions is often difficult; small juxtapyloric lesions are a notorious source of error. It is sometimes impossible to determine whether an ulcer is prepyloric or postpyloric. Such errors, however, are small in number compared with misunderstandings by clinicians and surgeons as to the reservations implicit in certain roentgenologic diagnoses and reports. Most of these misunderstandings arise from the diagnosis of benign tumors and gastric ulcer, and from reports as to the operability of cancer.

Benign tumors have a characteristic appearance, and are usually diagnosed without difficulty. A fairly large percentage of these have small areas of malignant degeneration present when examined microscopically. The roentgenologist is prone to assume that the clinician will remember this possibility; while the clinician generally charges him with an error when the pathological report indicates malignant change. Benign and malignant types of ulcer are usually readily distinguishable, but in a certain proportion only a diagnosis of ulceration can be made, with the presumption of benignity implied by the absence of a contrary diagnosis. This leaves the fact that about 10 per cent of such ulcers are malignant to be allowed for by the clinician, who sometimes assumes that the lesion is benign, to the subsequent surprise and vexation of all concerned. While it is possible for the roentgenologist to cover such a contingency in his report, such a report would hardly be complimentary to the intelligence of the other consultants.

The estimation of operability depends on the technical skill of the surgeon as well as the anatomical extent of the disease. Unless the roentgenologist is thoroughly familiar with the customs of his surgical colleagues his estimates of operability may prove a source of dissension. Metastases to the abdominal nodes, which cannot be determined roentgenologically, are a very frequent cause for the abandonment of operation in an otherwise resectable growth. Since about half the apparently resectable cases prove on operation not to be so, roentgenologists would probably do better not to make any statement on this score, since operability can be determined only by exploration.

LEWIS G. JACOBS, M.D.

**Multiple Gastric Polyposis. A Supplementary Report of 41 Cases, Including 3 New Personal Cases.** Felix L. Pearl and Harold Brunn. *Surg., Gynec. & Obst.* 76: 257-281, March 1943.

This paper is an analysis of 41 cases of gastric polyposis in which 3 or more polyps were present, including 3 personal cases. All these have been collected since the authors' earlier report of 84 cases (*Surg., Gynec. & Obst.* 43:559, 1926).

Multiple gastric polyposis is not common, though many cases are undoubtedly overlooked because of lack of symptoms. It may be congenital (neoplastic) or inflammatory (hyperplastic). The two types may often be differentiated on gross examination alone. There are no symptoms which are characteristic of this disorder. In the authors' series, epigastric pain and tenderness were most frequent. In over half of the cases, blood was found in the vomitus, stool, or gastric contents. Physical findings are indefinite and may be entirely lacking.

Diagnosis is attended by considerable difficulty. The x-ray may fail to differentiate multiple polyposis from chronic hypertrophic gastritis, retained food, bezoar, or sarcoma. In the present series of 41 personal and collected cases, the correct diagnosis was made by x-ray in 17, by operation in 13, by examination of the excised surgical specimen in 5, and by autopsy in 6. Gastroscoy is a valuable aid especially in the differentiation between benign and malignant lesions and between polyposis and hypertrophic gastritis. The combined use of roentgenography and gastroscopy will afford increased accuracy of diagnosis. Examination of the gastric content is of great importance. Of 24 cases in which it was done, 22 showed no free hydrochloric acid. The presence of anacidity in multiple polyposis is even more common than in carcinoma. A careful search should be made in the gastric content for tumor particles which may establish the diagnosis.

In the authors' previous series malignant alteration was noted in 12 per cent; of the present series, data as to malignancy were omitted in 4 of the cases; malignant alteration was found in 19. This alone, the authors believe, argues for radical surgical removal by gastric resection once the diagnosis is made.

Details of the 37 cases from the literature are given in tabular form and the authors' 3 cases are reported in detail. Illustrations and a bibliography of 119 references are included.

**Fibroma of the Stomach: A Case Report.** H. M. Wiley. *J. Missouri M. A.* 40: 171-174, June 1943.

Benign tumors of the stomach are infrequent, often being incidental findings on postmortem examination. While they may be asymptomatic, they also may mimic a malignant neoplasm. Roentgen examination is best suited for diagnosis. A circumscribed defect is found, frequently on the gastric walls, not affecting the curvatures. The surrounding rugae are usually normal in their arrangement. There is little disturbance of peristalsis, and retention is uncommon unless the lesion is at the pylorus.

The author's patient was a male, aged 51, in whom a diagnosis of a gumma of the stomach was first made. This was later changed to gastric carcinoma, and a subtotal gastric resection was done. The microscopic diagnosis was fibroma of the stomach.

HENRY K. TAYLOR, M.D.

**Roentgenologic Changes in the Small Intestine in the Presence of the Hookworm.** George R. Krause and James A. Crilly. *Am. J. Roentgenol.* 49: 719-729, June 1943.

Roentgenologic studies of 44 patients with clinically significant hookworm disease demonstrated the presence of abnormalities of the small intestinal pattern similar to those described by others as the "deficiency pattern" in 40 cases; in 26 of these the changes were classed as moderately severe or severe. Of 53 patients with asymptomatic incidental hookworm infestation, 33 had a normal small intestine, 16 showed minimal variation from the normal, and only 4 had severe alterations of the normal pattern. The hookworm itself is too small for roentgenographic demonstration. In the more advanced cases irregularities of the mucosa were present and occasionally the mucosal pattern was entirely obliterated. Flocculation was always present in the moderately and severely altered small intestine. Alterations in muscular function were frequently observed in the form of hypermotility with localized areas of segmentation, but hypomotility and dilatation were characteristically seen only in far advanced cases.

Twenty-nine patients were re-examined after successful anthelmintic therapy at intervals varying from five weeks to six months. Of 11 of these who had moderately or severely damaged small intestine, 8 showed improvement and 3 showed no change. None returned to the normal after therapy. This confirms the experience of others reporting on deficiency patterns due to other causes, in that severely distorted small intestines may return toward but not to the normal. The cause of the changes is still obscure.

L. W. PAUL, M.D.

**Intestinal Strangulating Obstruction with Negative Roentgenologic Findings.** Leon Goldman. *Surgery* 13: 834-846, June 1943.

The difficulties of recognizing internal intestinal strangulating obstruction are well known. The pain may simulate that of perforated peptic ulcer, twisted ovarian cyst, acute pelvic inflammatory disease, or mesenteric infarction or thrombosis. The venous return is often occluded first, so that the involved loop quickly fills with blood, which usually replaces any gas that may be present. The physical findings simulate those of peritonitis rather than simple intestinal obstruction. The presence of fever, tenderness, rigidity, a palpable abdominal mass, or leukocytosis is usually evidence that the blood supply has been interrupted.

Four case reports are given. Three of the patients were women of middle age or older who had had operations from eight to sixteen years before the onset of the present illness; the fourth was a 34-year-old man who had an appendectomy six years previously. In each case the onset was marked by a sudden cramp-like pain, becoming continuous and spreading over the entire abdomen, followed by vomiting. On entrance to the hospital all patients showed fever and leukocytosis and in 3 a palpable abdominal mass was present. Roentgenograms failed to show any small bowel distention or fluid, although in all some gas was demonstrable in the stomach or large bowel. Operation was done in each instance shortly after the x-ray was made and sections of gangrenous small bowel of various extent were found. The obstruction was due in every case to a fibrous band, which also occluded the mesen-



teric blood supply. The obstructed loops were heavy and filled with sanguineous fluid and there was sero-sanguineous fluid in the peritoneal cavity.

The interest aroused by these cases, with few or no roentgenologic evidences of obstruction on the plain film, stimulated experimental work in an attempt to explain the mechanisms involved. In order to simulate more closely the mechanism of internal strangulating obstruction, a method was devised for the gradual production of experimental strangulation. Changes which take place when a loop of intestine and its blood supply are gradually constricted are venous engorgement, perivascular hemorrhage, venous stasis, edema, cyanosis, spasm of the affected loop of bowel, and hemorrhage into the lumen and wall of the bowel. The mesentery becomes edematous so that the arterial supply is also encroached upon at the neck of the constriction and the lumen of the bowel is occluded, thereby setting up a vicious cycle, until perforation and peritonitis take place or a sufficient hemorrhage accumulates in the long segment to be an added factor in causing shock or death.

Three groups of experiments were carried out.

In *Group I* sudden obstruction was produced by ligating a loop of ileum, 40 cm. in length, with its blood supply, approximately 75 cm. proximal to the ileocecal valve. Subsequent roentgen study showed evidence of accumulation of gas and fluid proximal to the strangulation within ten hours in all the animals, the earliest appearing in two and a half hours.

In *Group II* a loop of ileum 40 cm. long with its mesentery was exteriorized over a linen string, the height of which could be regulated above the level of the anterior abdominal wall. The loop was permitted to hang apron-like over the string. The height of the string was then adjusted to a level that would produce venous engorgement. The bowel was handled gently and kept warm. In some dogs arterial pulsation disappeared within two and a half hours and in others continued for six hours. X-ray films, made within six to ten hours, showed definite accumulations of gas in 7 of the animals. In 3 no gaseous accumulation or distention occurred proximal to the obstruction.

In *Group III* 10 dogs were treated in a similar fashion except that the loop was left in the abdomen and the linen string anchored to the lateral border of the rectus sheath on each side. The string was placed under sufficient tension that engorgement of the venous return occurred. The x-ray films of 8 of the 10 dogs showed evidence of obstruction as characterized by gaseous distention of the small bowel. These findings occurred at six hours in 2, at twelve hours in 3, and at eighteen hours in 3 animals. The other 2 showed no roentgen evidence of gaseous distention after twenty-eight hours. The bowel was gangrenous and autopsy disclosed thrombosis of the involved mesenteric veins.

Discussing these observations, the author points out that roentgen evidence of obstruction was absent in from 20 to 30 per cent of the animals in which occlusion was produced gradually. It is considered possible that mesenteric venous occlusion may occur, causing a state of gangrene in the bowel before the lumen is obstructed, or that the occlusion may provoke a profusion of irritating serosanguineous fluid resulting in an inhibition of peristalsis and signs of peritonitis so that the x-ray films suggest adynamic ileus or no findings at all. It is suggested, also, that the irritative effect of a band or hernial ring may, by damage of the intima,

initiate a venous thrombosis as is produced by simple ligation of a blood vessel.

J. E. WHITELEATHER, M.D.

**Carcinoma of the Large Bowel, Excepting the Rectum.** O. Häuptli. Schweiz. med. Wchnschr. 73: 737-741, June 5, 1943.

The author discusses at length the symptoms, complications, prognosis, and treatment of cancer of the proximal colon. He prefers a one-stage radical hemicolectomy, but on occasion employs a two-stage or three-stage operation. In a series of 57 operable cases, there were 20 cures and 28 deaths from various causes. Three of 12 patients with inoperable cancers were living after palliative operations.

LEWIS G. JACOBS, M.D.

**Solitary Diverticulitis of the Cecum.** Joel W. Baker and Thomas Carlile. J. A. M. A. 122: 354-356, June 5, 1943.

Thirty-seven cases of solitary diverticulitis of the cecum have been found in the American and British literature. This excludes cases in which more than one diverticulum was present and those in which the pathological condition was not primarily diverticulitis. The authors report two more cases and present an interesting analysis of the clinical pictures and operative findings in the collected series of 39 cases. The mortality rate was one out of the 39.

The conclusion is reached that solitary diverticulitis of the cecum cannot be differentiated from appendicitis, that the operative differential diagnosis is of the utmost importance in determining the type of procedure to be followed, and that the outlook is favorable for complete recovery.

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UNIVERSITY OF MICHIGAN (R. H. M.)

**Endometriosis: A Study of 117 Cases with Special Reference to Constricting Lesions of the Rectum and Sigmoid Colon.** E. L. Jenkinson and W. H. Brown. J. A. M. A. 122: 349-354, June 5, 1943.

The authors state that the importance of endometriosis as a cause of constricting lesions of the rectum and sigmoid colon has not been sufficiently stressed, resulting in overly frequent confusing of the condition with neoplasm or inflammatory disease, with subsequent needless resection or fruitless medical management. They show by their own series, substantiated by the reports of others, that the incidence of endometriosis involving the rectosigmoid colon is considerably higher than might be expected. Of 117 cases of endometriosis, 47 showed at operation varying degrees of involvement of the rectosigmoid colon.

The history and symptomatology are important. Of the 47 patients, 21 had symptoms indicating some degree of obstruction, and of these, 14 gave a history of exacerbation of the bowel symptoms during or just before menstruation. The average duration of symptoms tends to be longer than for carcinoma. The incidence of gross or occult blood is low, since in most cases only the serosa and muscular layers are appreciably involved. This similarly decreases the diagnostic value of sigmoidoscopy and biopsy.

Roentgenologically the lesions are characterized by a long filling defect having sharp regular borders, intact mucosa, inconstancy of the filling defect, and fixation



of the bowel, which is exquisitely tender to palpation. In the less advanced cases there was a well demarcated, localized, irritable segment, usually three to five inches long and quite tender on palpation, especially before or during menstruation.

All constricting lesions in this series had returned to normal caliber when examined more than two months after surgical castration.

DEPARTMENT OF ROENTGENOLOGY  
UNIVERSITY OF MICHIGAN (R. H. M.)

### THE SPLEEN

**Cysts of the Spleen.** John W. Snyder and Philipp R. Rezek. *South. M. J.* 36: 263-268, April 1943.

Some 108 cases of non-parasitic cysts of the spleen had been reported in the literature up to 1941. By contrast, echinococcus cysts are relatively common. Cysts of the spleen may be classified as primary, which includes congenital, traumatic, inflammatory, neoplastic, and parasitic conditions; (2) secondary or false cysts, which may be traumatic, degenerative, or inflammatory.

This paper is concerned mainly with the clinically more important secondary group. Fowler has written extensively on the subject (see, for example, *Surg., Gynec. & Obst.* 70: 213, 1940), and the authors quote freely from his papers. He found trauma to be an etiologic feature in 23 per cent of his cases. Of his traumatic group, 80 per cent were large solitary hemorrhagic cysts, 15 per cent were serous, and 5 per cent lymphatic. Clinical symptoms, although numerous, are not pathognomonic, being largely the result of pressure upon the neighboring organs. Roentgen study may demonstrate a downward displacement of the splenic flexure, which is of great diagnostic significance. The stomach tends to be displaced to the right and backward. Pressure on the kidney may result in distortion and displacements in the pyelogram. Splenectomy is the treatment of choice.

The case of a 37-year-old white woman, in the fourth month of pregnancy, is presented. Her chief complaint was an abdominal mass in the left flank. An exploratory laparotomy was performed and a huge hemorrhagic cyst was encountered. After aspiration a splenectomy was performed. The patient made an uneventful recovery and later was delivered of a normal child by cesarean section. The cyst was believed to be lymphogenous in origin with superimposed hemorrhage.

A bibliography is appended. MAX MASS, M.D.

### THE SKELETAL SYSTEM

**Variability in Onset of Ossification in Epiphyses and Short Bones of the Extremities.** Idell Pyle and L. W. Sontag. *Am. J. Roentgenol.* 49: 795-798, June 1943.

Tables are presented showing the time and order of onset of ossification of the epiphyses and short bones of the extremities in boys and girls. Children studied include 64 boys and 69 girls, all white and American born. Many of these subjects were observed roentgenographically from birth to the age of nine years. Standard deviations and coefficients of variability are presented.

Carpal and tarsal bones are definitely more variable in time of appearance than are true epiphyses. However, no marked difference in order of ossification in advanced or retarded children or those growing at an

average rate was observed. There was no evidence in the material examined that illnesses common to this age level had a specific delaying action on centers due to calcify just at the time when the illness occurs.

L. W. PAUL, M.D.

**Development of the Vertebral Column as Related to Certain Congenital and Pathological Changes.** J. L. Ehrenhaft. *Surg., Gynec. & Obst.* 76: 282-292, March 1943.

The purpose of this paper is to discuss the development of the vertebrae and intervertebral disks and to point out the embryologic basis of certain confusing lesions encountered in later life. Not all developmental defects in the vertebrae-disk column can be explained on the basis of malformations in the mesenchymal and cartilaginous embryonic states. Many, however, become easily understandable if one considers the vascular supply and the changes which occur in the notochord during the different stages.

*Congenital synostosis*, with complete or partial bony fusion of two or more vertebral bodies with no evidence of interposed intervertebral disk tissue, or possibly only small amounts, occurs on the basis of a complete regression of the primitive annulus fibrosus.

*Sagittal cleft vertebrae* are due to a persistence of the ventrodorsal extension of the perichordal sheath with or without persistence of the chorda or splitting of the notochord in this area. Fusion of the laterally situated cartilaginous vertebral halves may thus be prevented and each half may become ossified separately by its anterior and posterior centers, with persistence of the sagittal cleft. With subsequent weight-bearing, the so-called "butterfly vertebral bodies" may occur.

*Lateral half vertebrae* or wedge vertebrae may be either unilateral or bilateral. They have been attributed to failure of cartilaginous development and to lack of blood supply to the missing half of the vertebral body. Bilateral half vertebrae are most commonly explained on the basis of a faulty unilateral cranial hemimetameric shift of the vertebral segments in the blastemic period. This shift will cause an anlage for a half vertebra to remain at the lower and upper ends of the unequally shifted column, which will later undergo chondrification and ossification.

*Ventral and dorsal half vertebrae* are rare and are explained on the basis of faulty vascularization and agenesis of either the anterior or posterior center of ossification. The malformed vertebral bodies will at times take the form of wedges as soon as weight-bearing is started, resulting in a deformity of the gibbous type.

*Malformations of the chorda and chordal remnants* result from the migration of notochordal cells during the cartilaginous period of embryonic development. Among the more frequent abnormalities are the outpouchings of the otherwise normal intervertebral disk, usually associated with thinning of the cartilage plate in the zones where the mucoid streak entered the intervertebral disk. These weakened places are often the site of centrally placed nuclear prolapses.

*Congenital weakness of the cartilage plates.* In areas where the cartilage plates are penetrated by vessels from the vertebrae, chondrification gaps develop. These areas form points of lessened resistance to the increased turgor of nuclear material, and at times the latter will be forced through these gaps to form spongiol prolapses. If this occurs during the actively growing state of the adolescent period, the process will

be a rather gradual one, stimulating considerable cartilage formation, but little reactive bone. Thus, often no reactive bony cup can be seen early in the x-ray pictures. Also, no true tears of the cartilage plate will result. In older persons, the prolapsing material is more of a fibrous nature and the reparative process proceeds rapidly to reactive bone and a bony cup becomes visible in x-ray pictures.

**Osteomyelitis of the Long Bones in the Newborn.** Samuel Stone. *Am. J. Dis. Child.* 64: 680-688, October 1942.

Osteomyelitis of the long bones in the newborn is uncommon, and since it differs in its course and prognosis from osteomyelitis in older children, the author has reviewed the reports thus far appearing in the literature.

The report of Green and Shannon in 1936 (*Arch. Surg.* 32: 462, 1936) emphasized the difference between osteomyelitis in infants under two years of age and the disease in older persons. The streptococcus was the etiologic organism in 63 per cent of the cases. Wounds healed rapidly after operation, frequently in from four to six weeks. Sequestration was infrequent. Healing of the lesion was so complete that in many instances the site could not be recognized in the final roentgenogram. Subperiosteal new bone was visible much sooner than in older children. Immobilization, poultices, and supportive treatment was the usual procedure in these cases. Operation was not performed unless a palpable mass was present.

While osteomyelitis in the newborn child may be a benign disease, it is pointed out that in the presence of sepsis with metastatic foci the prognosis is grave.

The author adds 4 cases to the literature and comments on the benign course in each case, the quick healing of the osseous lesions, the rapid subperiosteal new bone formation, short period of drainage, and complete healing without sequestration. It is noted that the vascular spores in the bones of infants are larger and the bone of a more spongy texture than in older children; also that the cortical bone is particularly thin at the metaphysis and the periosteum is more loosely attached. All of these factors allow more rapid decompression of pus and decrease the incidence of gross sequestration. The fact that necrotic bone is more rapidly absorbed in infants and that new bone is formed more rapidly also helps to explain the benign course of the disease and the excellent prognosis.

GEORGE M. WYATT, M.D.

**Syphilitic Spondylitis.** Eugene Freedman and I. Meschan. *Am. J. Roentgenol.* 49: 756-765, June 1943.

The literature on syphilitic spondylitis is reviewed and the authors report 3 cases observed by them. The lesion shows a marked predilection for involvement of the cervical vertebrae, for reasons unknown. The symptomatology is not definite. There are localized pain, which may be more marked at night, stiffness, and tenderness to palpation as the result of periostitis. Roentgenologic examination shows evidence of destruction of the vertebral bodies, especially on their ventral aspect, but there also is a strong tendency to osteosclerosis and hyperostosis. There usually is calcification in the anterior and lateral ligaments, leading eventually to complete ankylosis. The tendency to eburnation predominates over the tendency to destruction. The intervertebral space may be narrowed or of normal width. In the cervical region the ligaments

tend to ossify in a rather uniform and smooth fashion, while in the lumbar or dorsal areas, large pointed spurs may develop along the anterolateral borders of the end plate. Such appearances may simulate a degenerative arthritic process. Significantly, in syphilitic spondylitis the process is usually localized to two or three vertebrae in contrast to the more widespread changes in degenerative lesions.

While the roentgen appearance may suggest the possibility that a syphilitic spondylitis is present, other factors are necessary to substantiate the diagnosis, including evidence of active syphilis, either as determined by the history or by clinical or serological manifestations; development of the lesion at an age when tuberculosis of the spine is rare, and with an absence of tuberculosis elsewhere; rapid improvement upon institution of antisyphilitic therapy, and the predilection of the disease for the cervical region, although it may occur elsewhere in the spinal column.

L. W. PAUL, M.D.

**Anterior Sacral Meningocele.** Frederick A. Collier and Richard G. Jackson. *Surg., Gynec. & Obst.* 76: 703-707, June 1943.

Anterior sacral meningocele is a rare condition, only 22 cases having been previously reported in the literature. Eighteen patients were treated. Of these, 8 were cured, 2 remained the same, and 8 died. If the condition is unsuspected, inadvertent opening or aspiration of the sac may lead to meningitis.

The meningocele enters the pelvis through an anterior defect, which is usually laterally placed. However, the tumor may herniate through the sciatic foramen and present posteriorly. The diagnosis is suggested by a life-long history of constipation, palpation of a fluctuant retrorectal tumor, and x-ray demonstration of a sacral deformity. Treatment should be conservative unless the symptoms are severe or the danger of the meningocele complicating pregnancy arises. Operation consists in approaching the tumor through a posterior mid-line incision, ligating and sectioning the pedicle. The wall of the sac does not have to be excised, since it does not secrete spinal fluid.

The author presents the record of a case successfully treated surgically. An x-ray film of the pelvis showed profound deformity of the sacrum, suggesting non-development of the right half, displacement of the left half toward the left, and displacement of the coccyx to the horizontal position. A barium enema showed the rectum displaced and compressed, and the sigmoid displaced upward. The left innominate bone was rotated somewhat and the sacroiliac joints were slightly widened. The bone margins were smooth and not eroded. The preoperative diagnosis was a developmental lesion which might be a dermoid or anterior sacral meningocele. Surgical treatment, consisting of ligation of the pedicle, was successful.

DAVID KIRSH, M.D.

**Multiple Cystic Tuberculosis of Bone.** F. Ziady and G. Selzer. *Clin. Proc. (Cape Town, South Africa)* 1: 346-356, October 1942.

A case of multiple cystic tuberculosis of the bone is described. The patient, a colored girl seven months of age, had a generalized lymphadenopathy, with nodes of varying size. Behind the left ear was a deep sinus from which pus was oozing; this communicated with the middle ear and mastoid.

Roentgenograms revealed a multitude of lesions diffusely scattered throughout the body. X-rays of the skull showed several well defined areas of erosion in the frontal and the parietal regions, with some linear periosteal proliferation of the lower part of the frontal bone. In the long bones, carpal and tarsal bones, and ribs were multiple areas of translucency of various size; there was some periosteal proliferation of the linear type along the shafts of the humeri, femora, tibiae, and fibulae. The lower end of each femoral diaphysis was expanded. A greenstick fracture of the upper end of the left tibia was present. Films of the chest showed scattered rounded areas of opacity in the lung fields, larger than those seen with miliary tuberculosis. The blood Wassermann reaction was strongly positive.

Diagnosis was difficult, the following conditions being suggested: generalized tuberculosis, Boeck's sarcoidosis, syphilis, a lipid disturbance of the Hand-Schüller-Christian type.

At autopsy the nodes, bony lesions, and pulmonary lesions were shown to be due to tuberculosis.

**Syndrome of Atlanto-Axial Dislocation.** G. M. Bull. Clin. Proc. (Cape Town, South Africa) 1: 336-345, October 1942.

The author gives a brief description of the anatomy of atlanto-axial dislocation and classifies the types of dislocation of the atlas on the axis as (1) fracture of the odontoid process with subluxation of the atlas on the axis (the most frequent type of dislocation); (2) rotary dislocation of the atlas on the axis, due to excessive rotation of the head on the trunk; (3) simple subluxation of the atlas and the skull on the axis without fracture of the odontoid. This type of dislocation is extremely rare.

Two cases are presented: one of anterior dislocation of the atlas on the axis with fracture of the odontoid peg and the other a very unusual case of forward dislocation of the atlas on the axis without fracture of the odontoid.

**Traumatic Dislocation of the Hip with Fracture of the Acetabulum.** Alfred M. Okelberry. Minnesota Med. 40: 378-383, June 1943.

The hip joint is susceptible to injury in three periods of life: infancy, old age, and under certain circumstances in middle life. In cases of traumatic dislocation, fracture of the acetabulum may be a complication; it occurs when the hip is not adducted and when the femoral head is still partly in contact with the acetabulum.

Campbell divides dislocation with acetabular fracture into three types: (1) slight backward and upward displacement of the femoral head; (2) displacement of the femur more than a half-inch upward; (3) displacement of the femoral head upward and backward onto the wing of the ilium.

The author discusses treatment. If traction fails, open reduction is resorted to. Three case histories are presented.

The author comments on the possibility of aseptic necrosis occurring in dislocation of the femur. Quoting Potts and Obitz, he states that this may be delayed until as long as five years following injury. [There will be many to question this concept. As we have come to understand aseptic necrosis of the femoral head as presented to us by Phemister and others, the occurrence of such a process after five years of active weight-

bearing is certainly not well understood, and even less well understood would be the manner in which a reparative "creeping substitution" would operate. Furthermore, the roentgenogram presented by the author as evidence of aseptic necrosis is not convincing].

PERCY J. DELANO, M.D.

**Arthroplasty of the Hip for Osteoarthritis, Utilizing Foreign-Body Cups of Plastic.** Paul H. Harmon. Surg., Gynec. & Obst. 76: 347-365, March 1943.

This presentation deals with two subjects: arthroplasty utilizing foreign substances of non-animal origin and end-results of these and other methods in ameliorating pain and disability in osteoarthritis of the hip. Late results, approximately eighteen months following foreign body cup arthroplasty of the hip, are reported in 13 cases (16 hips). Results have been "excellent" in 10 hips or 62.5 per cent, "good" in 3 hips or 18.7 per cent, and "poor" in 3 hips or 18.7 per cent. It is the author's impression that the relief from pain is definitely greater with the use of the plastic cup (molded from sheet material) than following metallic cup arthroplasty. Surface hardness of the interposed material probably is the responsible factor, since relief from pain was far less in 3 patients upon whom an arthroplasty with a pure fused quartz cup was used. A simplified operative technic is described which is applicable in the presence of a movable hip. The plastic cup also has the advantage of being transparent to the roentgen ray, so that osseous changes occurring in the hip can be visualized.

The gross and microscopic alterations of the osteoarthritic femoral head, based upon the study of roentgenograms of 94 osteoarthritic hips and the direct observation of approximately 60 osteoarthritic hips at operation, are described. The changes to be seen in roentgenograms of the "early osteoarthritic hip" include marginal osteophytes at the head and neck junction or at the lateral acetabular margin, widening of the femoral head by growth of its adductor portion as seen in the anteroposterior film, and sclerosis within the head and above the acetabular articular bony cortex (supra-acetabular sclerosis). At this time the superior "joint space" may be normal or slightly diminished. As further changes take place, spotty sclerosis appears in the head, denoting osseous infarction or endosteal proliferation. Marginal osteophytes increase in size and especially the adductor portion of the head becomes disproportionate. In advanced cases the adductor osteophyte may be half as large as the head itself and may cause partial dislocation of the latter. This portion of the head may render the femoral head egg-shaped and be a major factor in causing it to be difficult to dislocate at operation and in restricting motion of the joint. The head increases in size both by subchondral sclerosis and by its enlargement by osteophytic proliferation. Subchondral sclerosis is accompanied or preceded by changes in cartilage. As a result, irregular islands of cartilage thinning occur, which in advanced states may bare subchondral bone. Cartilage is thrown up into pleat and ridge formation, the whole giving the head an irregular appearance. The extent of marginal overgrowth of bone and cartilage never parallels the rate of degeneration of cartilage over the head and of actual enlargement of the osseous structure of the latter. Consequently, osteoarthritic femoral heads are never identical.

Most of the alterations which are seen in the customary anteroposterior roentgenograms of the hip and which appear to be acetabular osseous overgrowths are actually alterations on or in the femoral head. Such roentgenograms seldom give an accurate impression of the relative changes in the femoral head and acetabulum as actually visualized at operation. Lateral views of the hip with leg abducted and externally rotated are of help in visualizing the extent of relative involvement of the femoral head prior to operation.

The operative technic is described and case reports, with illustrations, are included.

## OBSTETRICS AND GYNECOLOGY

**Roentgenographic Obstetrical Pelvicephalometry in the Erect Posture.** Robt. P. Ball and Ross Golden. *Am. J. Roentgenol.* 49: 731-741, June 1943.

One of the authors previously had described a method of roentgen pelvimetry and fetal cephalometry which involved the determination of the volume of the fetal head from circumference measurements taken from right-angle views (*Radiology* 24: 77, 1935; 31: 183, 1938). For the past five years the erect position has been used for this purpose in order to eliminate the possibility of a change in the relation of the uterus to the axis of the maternal body when the patient is turned from the anteroposterior to the lateral position. The present paper describes the technic used in making the roentgenograms and discusses their interpretation with particular reference to the quantitative relationship between the size of the fetal cranium and the maternal bony pelvis. A previously described nomogram is used to calculate the pelvic diameter.

The diameters measured include the anteroposterior and transverse of the inlet, the interspinous, intertuberous, base of the subpubic arch, sagittal diameter of the fore pelvis and of the posterior pelvis. The roentgen report includes, also, a description of pelvic configuration.

The total volume of the fetal cranium is calculated from the mean circumference measurement of the cranial image as seen in right-angle view. In any pelvis the obstetrical conjugate or the biischial spine diameter will be the smallest internal pelvic diameter. If the mean circumference measurement of the fetal head plus scalp is translated into units of volume, it can be compared to the volume capacity of one of these internal pelvic diameters, *i.e.*, to the volume of the largest sphere which could pass through. When the volume of the head is less than the volume capacity of either of these diameters, there is no bony disproportion present. Even when the volume of the fetal head is greater than the volume capacity of either diameter, important bony disproportion is not necessarily indicated, if molding of sufficient degree can occur, thus reducing the size of the head in the direction of the narrow diameter, or if compensatory space is present so that the widest portion of the fetal head does not have to pass through the narrowest pelvic diameter. Because of the variables involved, namely, uterine force, molding, and the amount of compensatory space, arbitrary limits cannot be set. As a general principle, however, it can be stated that the smaller the pelvis and the greater the excess of fetal head volume over the volume capacity of the smallest pelvic diameter, the greater the danger of difficulty in delivery.

L. W. PAUL, M.D.

**Analysis of Roentgen Pelvimetry by the Johnson Stereoroentgenometer in 379 Cases.** J. N. Ané and Leon J. Menville. *Am. J. Roentgenol.* 49: 742-749, June 1943.

The method of roentgen pelvimetry previously described by Johnson (*Radiology* 8: 518, 1927) was used by the authors in the study of 450 consecutive obstetrical patients. The average diameters in these cases are shown in tabular form. Information relative to the type of delivery was obtained in 379 patients. Analysis of the pelvic diameters obtained in these 379 cases showed that in 216, or 56.9 per cent, all diameters were normal or greater than the accepted average diameters; in 95 patients, or 25.1 per cent, one or more were shortened from 5 to 10 mm.; and in 68 cases, or 17.9 per cent, diameters were contracted over 10 mm. In a series of 205 patients with normal diameters as determined by the stereoroentgenogram, 203, or 99 per cent, had normal deliveries. In a group of 61 patients in whom more than one diameter was contracted more than 10 mm., 52, or 85.2 per cent, had difficult or prolonged labors or required operative deliveries.

This study emphasizes the importance of the interspinous or transverse diameter of the mid-plane in pelvimetry. Of 45 patients with contraction of the interspinous diameters of over 10 mm., only 3 delivered normally.

The authors conclude that the Johnson method of stereoroentgenometry combined with the stereoscopic study of the relationship of the bony pelvis and the fetal skull is of considerable value in the prognosis of the future course of pregnancy. L. W. PAUL, M.D.

**Comparative Value of Roentgen versus Clinical Methods of Pelvic Examination in Obstetrics: Roentgenologic Aspects.** Samuel G. Henderson. *Pennsylvania M. J.* 46: 902-906, June 1943.

Roentgen studies are of primary importance in disclosing pelvic configuration and relative size of the fetus and maternal pelvis. Studies are best made late in pregnancy, as in the early months x-ray may hold an element of danger to the fetus. Furthermore, if the studies are made in the ninth month of pregnancy, a statement can be made concerning the relative size of the fetus and maternal pelvis.

To be of most value a technic must be simple, practical, and technically accurate; it should give the size and shape of both the inlet and outlet of the pelvis. The author employs the perforated plate method, using three films, anterior-posterior, lateral, and a film of the subpubic arch. He also uses precision stereoscopy as outlined by Caldwell and Moloy.

Female pelves are divided into four types, gynecoid, android, anthropoid, and platypelloid, each major type having modifying characteristics ordinarily seen in the other major groups.

A roentgenologist's description of the pelvis should include its type, the inlet and the angle of the fore-pelvis, whether average, narrow, or wide, and the slope of the pelvic sidewalls. In the lateral view the configuration of the pelvis should be determined—whether flat, concave, or convex anteriorly. The true conjugate, posterior sagittal diameter, and the size and shape of the sacrosciatic notch should be described. The fetal skull is measured in its greatest sagittal and transverse diameters.

In a study of 329 pregnant women there were 233

gynecoid, 14 android, 45 anthropoid and 37 platypelloid types of pelvis. Vertex presentations were found in 291 cases, breech position in 27, transverse position in 2, and face position in 1. Twins were present in 5 cases. Cephalopelvic disproportion was diagnosed in 94 patients; it was marked in 18, moderate in 54, and borderline in 22 cases.

A paper on the clinical aspects of pelvic examination follows this contribution. See following abstract.

JOSEPH T. DANZER, M.D.

**Comparative Value of Roentgen versus Clinical Methods of Pelvic Examination in Obstetrics: Clinical Aspects.** Howard A. Power. *Pennsylvania M. J.* 46: 907-909, June 1943.

This paper follows one on the roentgenologic aspects of pelvic examination, abstracted above. Two hundred and twenty-nine of the women who were studied roentgenologically were also examined clinically. The two examinations were in complete agreement as to the type of pelvis in 98 cases; they disagreed at least partially in 131, and in 88 cases there was absolute disagreement. In evaluation of disproportion there was agreement in 174 instances and disagreement in 55. Most of these disagreements represented borderline disproportion. In 16 cases in which the clinical opinion was questionable and the x-ray showed no disproportion, x-ray opinion was correct in the entire group. In 4 cases in which the clinical opinion was questionable and the x-ray showed disproportion, x-ray opinion was correct in 3. The x-ray opinion was also correct in 4 out of 5 instances when it showed questionable disproportion and the clinical examination was normal, and in 8 out of 12 cases where there was x-ray evidence but no clinical evidence of disproportion. In 10 out of 12 cases the x-ray evidence was correct in denying disproportion when clinical opinion reported that it existed.

The greatest mortality occurred in a group of 122 cases where there was no evidence, clinical or roentgenological, of disproportion. In this group there were three fetal deaths, 2 of the babies being macerated. The one maternal death was due to toxemia.

JOSEPH T. DANZER, M.D.

**Roentgenologic Localization of the Placenta Without Contrast Media.** R. Manges Smith. *Am. J. Roentgenol.* 49: 750-755, June 1943.

The literature on the subject of placental localization is reviewed and the author discusses his experiences with soft-tissue study of the placenta. In addition to two roentgenograms made in the anteroposterior and lateral positions for bone detail, an additional lateral roentgenogram is made with the soft-tissue technic. These three films usually afford sufficient information to make an accurate diagnosis of the position of the placenta. During the past six years over one thousand such examinations have been made. The placental shadow normally is usually on the ventral side of the fetus and is in continuity with the wall of the uterus. In placenta praevia the extent of shadow which is found in the body of the uterus depends upon the type and degree of placenta praevia. When this is complete, the placental shadow is absent from the upper uterine segment. While it is not usually visible in the lower segment either, because of its concealment by the pelvic bones, the high displacement of the presenting

part speaks for its presence there. Diagnosis in these cases, therefore, is dependent upon the absence of a placental shadow from the upper segment of the uterus and displacement of the presenting part from its normal position.

L. W. PAUL, M.D.

## GENITO-URINARY TRACT

**Layer Formation in Pyelography.** Alice Ettinger. *Am. J. Roentgenol.* 49: 783-794, June 1943.

As an explanation for certain pyelographic appearances, the author advances the theory that these may be due to layering of the lighter, stagnant urine in the kidney pelvis on top of the denser urine containing contrast medium. An example is the so-called "psoas border sign" in which the medial surface of the kidney pelvis is perfectly straight and parallel to the psoas muscle margin. This configuration is more frequent in cases of hydronephrosis, but may be demonstrated in normal-sized pelvises. If observations are carried out over a long enough period of time, a double medial border line of the renal pelvis is visualized. The author explains this on the basis of the layering phenomenon. If the films are made with the patient in various positions, there can be demonstrated a shifting of heavier dye-containing urine within the renal pelvis to the most dependent portion. Layer formation can be demonstrated experimentally if urine is collected before the intravenous injection of the dye and again at the end of intravenous pyelography. If one of these fluids is added carefully to the other, roentgenograms of the mixture will show a distinct difference in density of the two layers and they will remain separated for considerable periods of time.

L. W. PAUL, M.D.

## VENOGRAPHY

**Use of Venograms for the Localization and Study of Arteriovenous Fistula.** James R. Watson, J. M. Lichty, J. M. Hill, and R. B. Miller. *Surg., Gynec. & Obst.* 76: 659-664, June 1943.

The use of venography has been principally confined to the study of venous thromboses. Bauer had previously suggested that it might be of value in the study of arteriovenous fistulas, and the authors have confirmed this impression in their paper.

Arteriovenous fistulas produce changes in both the artery and vein, but the latter is the more adversely affected, manifesting varying degrees of hypertrophy and dilatation proximal to or at the level of the fistula. If the valves become incompetent, the adjacent distal segment of the vein may undergo the same changes. However, such dilatation is uncommon, for the arterial blood takes the course of least resistance and passes through the fistula and into the proximal vein.

The authors record 3 cases of arteriovenous fistula of the common femoral vessels in which venography proved to be a reliable means of locating the level of the fistula, as later proved at operation. In each case the vein distal to the fistula was normal. Ligation of the vein distal to the fistula at the time of injury in one case was not followed by the development of varicosities and edema. This was in sharp contrast to the other two cases, in which collateral circulation was through numerous dilated and tortuous superficial veins. The authors believe this suggests that ligation

of the vein distal to the fistula at the time of injury might exert the same beneficial effect on the limb that proximal ligation exerts on the heart.

Venography should be of special value in localizing fistulas when the physical signs are inadequate or even confusing, as when the fistulas are small, multiple, or

situated in the upper mediastinum or pelvis. It is also of value in the demonstration of fistulas at or proximal to the roots of extremities, where arteriography is difficult. Venography may be used in conjunction with arteriography when multiple fistulas are suspected.

DAVID KIRSH, M.D.

## RADIOTHERAPY

**Radiation Treatment of Lymphangioma.** George W. Holmes and Lloyd E. Hawes. *Am. J. Roentgenol.* 49: 799-802, June 1943.

The term lymphangioma includes a considerable variety of slow-growing, usually congenital tumors occurring in the skin and subcutaneous and deep arcolar tissues, occasionally invading the muscles of the neck, tongue, lip, and other structures. Three distinct forms have been described: *lymphangioma simplex*, which occurs chiefly in the skin and is composed of an anastomosing network of vessels or spaces of small caliber; *lymphangioma cavernosum*, which consists of a system of closed lymph spaces lined with endothelium; *lymphangioma cysticum*, consisting of a collection of cysts of varying size, lined with flat endothelium and containing lymph. Two other forms are usually added—the verrucous and the cystic hygroma.

The records of 12 cases treated with roentgen rays or radium during the years from 1930 to 1940 are presented. After 1940 radiation treatment was replaced by surgery as a general procedure. In only 2 cases was the diagnosis confirmed by biopsy so that histopathological classification is impossible, but the clinical diagnosis seems correct in a high percentage of the group. The use of biopsy as a means of diagnosing lymphangioma probably should be discouraged, since the findings are often inconclusive and because fatalities not infrequently follow infection.

The results of this review seem to indicate that there is only one form of lymphangioma, the verrucous type of lymphangioma simplex, which responds favorably to irradiation in doses which do not cause permanent injury to normal tissue. All other forms either do not respond at all or require a dose larger than can be given with safety. Infection is a hazard of treatment, particularly in the large tumors of the neck. For this reason the taking of biopsies and the insertion into the tumor of radium in the form of seeds or needles should be discouraged.

L. W. PAUL, M.D.

**Carcinoma of the Lung, with Freedom from Symptoms for Five Years.** N. Puente Duany and W. Figueras Gonzáles. *Rev. méd. cubana.* 54: 336-342, April 1943.

Puente Duany and Figueras Gonzáles present a case of carcinoma of the right upper lobe of the lung treated by deep roentgen therapy, with relief of symptoms. The patient was observed for a period of five years, the lung tumor remaining quiescent to the end. Death was attributed to late metastasis.

In the treatment a total of 7,000 r were given, in 20 daily doses through anterior, posterior, and lateral ports  $15 \times 15$  cm., at 50 cm. distance. The factors were 200 kv., 6 ma., filtration 1.0 mm. Al plus 1 mm. Cu, exposure time 30 minutes.

It is unfortunate that no biopsy was done and the type and grade of the tumor were not ascertained.

A. MAYORAL, M.D.

**Case of Ewing Tumor of the Right Femur, in the Epiphysis, with Unusual Pathological Fracture.** Guillermo Halley. *Rev. méd. cubana.* 54: 287-298, March 1943.

A case of Ewing sarcoma in a child of twelve, localized to the epiphysis of the right femur, is reported. The child suffered a spontaneous pathological fracture. Roentgen therapy caused some improvement, but the tumor metastasized to the lung and death occurred fourteen months after the onset of symptoms.

A. MAYORAL, M.D.

**Lymphogranulomatosis, with a Secondary Tumor of the Pharynx of Similar Nature.** N. Puente Duany. *Rev. méd. cubana.* 54: 173-180, February 1943.

Puente Duany reports a case of lymphogranuloma in which the primary lesion was localized to the cervical lymph nodes, with discrete infiltration of the lateral pharyngeal wall. The lesion responded well to deep roentgen therapy, but recurred. A second course of roentgen irradiation effected an apparent cure. Six months later, however, the patient was seen with a large tumor obstructing the nasal passages. This new growth the author suspected to be an epithelioma. Biopsy, however, revealed an invasive and infiltrating lymphogranuloma, which proved to be radioresistant.

The author believes that the roentgen dosage used for the original tumor was not sufficient to cure, although it did relieve the symptoms, and that it may have been the cause of the resistance of the second tumor to irradiation.

A. MAYORAL, M.D.

**Low-Dosage Irradiation to the Pituitary Gland and Ovaries in Amenorrhea and Dysfunctional Uterine Bleeding: A Long-Term Survey.** Leon Reidenberg. *Am. J. Obst. & Gynec.* 45: 971-979, June 1943.

The numerous clinical reports on low-dosage irradiation to the pituitary gland and ovaries include only a short follow-up period, one to three years. The present paper is based on a careful follow-up of 136 women who received this type of treatment from three to thirteen years ago. The results indicate that low-dosage irradiation, within the limits employed in these cases, is a helpful and safe agent. No deleterious effect upon the offspring of 54 women who have given birth to 80 children was found.

The technic generally used for ovarian irradiation was as follows: 135 kv., 5 ma., F.S.D. 40 cm., 6 mm. Al filter, size of field  $20 \times 20$  cm. Depending upon the thickness of the abdominal wall, 50 to 90 r (measured in air) were given three times at intervals of one week. The pituitary gland was treated with the same dosage at the same time through a portal  $3 \times 3$  cm., lateral fields being used. Partial relief of amenorrhea by one course of treatment seemingly justifies a second course within three to six months.

The patients to receive this type of radiation were carefully selected. Only those who showed no evidence

of a constitutional debilitating disease, diabetes, or thyroid malfunction were treated. A diagnostic curettage preceded treatment in most instances to eliminate the presence of intra-uterine disease. Women with premenopausal uterine bleeding were not treated. A biologic test was performed to exclude a chance pregnancy.

Thirty-six (or 71 per cent) of 51 patients with secondary amenorrhea of 6 months' to fifteen years' duration were restored to normal menstrual periodicity, and 4 of these conceived within three months after irradiation therapy. The effect on primary amenorrhea was equally interesting. Four patients (18 to 22 years) had never menstruated. One of these began to menstruate spontaneously two years after treatment and continued to menstruate normally for a further follow-up period of four years. In the other 3 treatment was ineffective.

Thirty-seven patients complained of oligomenorrhea, and 29 (or 78 per cent) of these were restored to normal menstrual rhythm. Of this group, 23 complained of sterility. Following irradiation, 17 conceived and carried to term 23 healthy infants.

Seven patients with hypomenorrhea were treated, of whom 6 sought relief of sterility. Four patients (57 per cent) were relieved of the menstrual disorder but only one was relieved of sterility.

Twenty-seven women menstruated cyclically but either excessively or for a prolonged interval. Sixteen (59 per cent) were restored to normal menstrual rhythm. Only one of the 4 patients in this group complaining of sterility was relieved.

Ten patients had totally acyclic menstrual rhythm for periods of six months to four years. None of these complained of sterility. Five were restored to normal menstrual rhythm; 3 were temporarily benefited and two were unaffected. STEPHEN N. TAGER, M.D.

**Therapeutic Abortion by X-Rays.** Carlos E. Gárciga. *Rev. med. cubana* 54: 270-280, March 1943.

The author calls attention to the beneficial effect of castration on cancer of the genital organs in the female. When pregnancy and cancer coexist, the latter will usually be aggravated. Roentgen therapy is recommended not only as a safe abortive, but to cause cessation of menstrual function. From the cases presented, the impression is gained that the usual dose is 2,500 r given in daily doses of 255 r to the right and left ovary alternately. Abortion usually takes place from the twenty-fifth to thirtieth day after the completion of the treatments. The best results are obtained in early pregnancy. A. MAYORAL, M.D.

**New Type of Radium Loading Protective Device.** Andrew H. Dowdy, Benjamin DuBilier, and Dean B. Cowie. *Am. J. Roentgenol.* 49: 803-810, June 1943.

A new type of radium-loading protective device is described. The old type of protective device had no sides, and the back and bottom were constructed of one inch of lead. The absence of lead sides permitted a direct exposure of the hands and fingers to the radium device. The new device is made with side walls of lead and the lead in the back and bottom has been increased from 1 to 2 inches in thickness. The radium and loaded applicators are manipulated by remote control. The design and the accessory instruments make it possible to shorten greatly the time necessary to load and unload the radium applicators. Charts are included showing the results of measurement tests obtained while unloading and loading different types of radium applicators. The authors believe that with reasonable care the average daily exposure from radium should not exceed 0.005 r in the average hospital. Diagrams and photographs of the device are included. L. W. PAUL, M.D.

## EXPERIMENTAL STUDIES

**Induction of Leukemia in Mice by Methylcholanthrene and X-Rays.** D. P. McEndy, Mary C. Boon, and Jacob Furth. *J. Nat. Cancer Inst.* 3: 227-247, December 1942.

Leukemia was produced in mice by repeated percutaneous applications of methylcholanthrene. The animals were killed at intervals, the blood-forming organs were examined microscopically, and transmission experiments were made with suspensions of cells from spleen and lymph nodes.

Numerous transmission experiments made before the eighth week of painting were uniformly negative, although hyperplastic changes were evident in lymphoid tissues. Three cases of leukemia were first demonstrated by transmission experiments. A subsequent microscopic review showed the presence of collections of atypical cells in the splenic pulp and in lymph nodes, while the bone marrow and liver showed no change. The numerous transmission experiments made from histologically definite cases of leukemia failed in only 1 of 46 injected mice. Of the tests used to determine the presence of leukemia, the gross examination is the least reliable, the microscopic examination next in order, and the inoculation experiments are the most decisive.

The type of leukemia produced was lymphoid or atypical, with the exception of a few myeloid or monocytic leukemias. Evidence is presented suggesting

that the atypical cells originate in lymphoid tissues.

The onset of induced leukemia is sudden when judged by the criteria studied.

In some of the experiments the mice were irradiated either before or after painting with methylcholanthrene. The following factors were used: 140 kv., 5 ma., 30 cm. T.S.D., with an inherent filter of 1 mm. aluminum. Under these conditions the output of the machine was 100 r in 0.7 minute. All irradiated mice received 300 r. The incidence of leukemia was slightly higher among the x-rayed and painted mice than among the mice painted but not x-rayed.

A preliminary study of blood smears indicates that the majority of induced leukemias are accompanied by specific blood changes recognizable at least two weeks before the death of the animal.

**Effect of Heparinization on Experimental Post-Irradiation Tissue Changes in the Lung: Preliminary Study.** Floyd Boys and Ivor D. Harris. *Am. J. Roentgenol.* 50: 1-7, July 1943.

Young adult white Belgian rabbits were treated with 200 kv. irradiation over the entire thorax. Each animal received a total of either 4,200 or 4,900 r. The period of roentgen irradiation was fourteen days, the treatment being given on alternate days. Control and experimental groups were used. The control group was



given irradiation alone, and the experimental group was heparinized with liquaemin in conjunction with irradiation.

These experiments seem to indicate that heparin has a definite effect on the inflammatory process in the lung parenchyma. The inflammation which follows roentgen irradiation damage to the lungs of rabbits is somewhat less extensive when heparin is administered than without heparin, and later changes (pulmonary fibrosis and pleural adhesion formation) are greatly diminished.

Since heparin is a dangerous drug, much more extensive work covering other types of inflammation is required before it will be possible to make practical use

of the phenomenon suggested by the results here obtained. However, these experiments suggest a new technic for the measurement of the effect of roentgen irradiation on various tissues, particularly in the field of malignant tumors. It is still apparently not established whether the effect of roentgen irradiation in checking malignant growth is entirely a direct destruction of the cancer cell or whether this destruction is much or little enhanced by the accompanying fibrosis. If fibrosis can be markedly diminished in the experimental animal with the use of heparin, there may be at hand a new biological method for measuring direct roentgen irradiation effect on cells in the living body.

CLARENCE E. WEAVER, M.D.







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PUBLISHED BY THE RADIOLOGICAL SOCIETY OF NORTH AMERICA

## EDITOR

Howard P. Doub, M.D., Detroit, Michigan

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John D. Camp, M.D., Rochester, Minn.

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## Roentgen Therapy of Wilms' Tumor<sup>1</sup>

EDWARD W. ROWE, M.D., and MAURICE D. FRAZER, M.D.

Lincoln, Neb.

**W**ILMS' TUMOR, adenomyosarcoma, or embryonal mixed tumor of the kidney, is the most common renal neoplasm occurring in infancy and childhood. Some examples, however, have been reported in adults. The prognosis in a majority of cases is generally unfavorable, and the course of the disease is usually rapid.

### SYMPTOMATOLOGY

The familiar triad of symptoms for renal neoplasms—hematuria, pain, and a mass—is not found in all cases of Wilms' tumor. The usual finding in these cases is a rapidly growing mass. In 2 of the cases to be reported here, hematuria was the initial symptom pointing toward a disturbance in the urinary tract. Persistent pain was not reported in any of the cases; but in 2, vague abdominal pain associated with gastric disturbances was noted over a period of several months. These vague abdominal pains were generally associated with meals. The blood pressure was not elevated in any of the cases to be presented. Hypertension may occur, however, in some instances, as observed by Bradley and Pincoffs in their series of cases (1). Trauma may be associated with the onset of the more severe symptoms, as occurred in Case III, reported below.

### PHYSICAL FINDINGS

The patient is usually a child averaging three to five years of age, fairly well nourished and in apparent good health. A mass in either flank, of varying size, smooth contour, and firm consistency, that moves on deep inspiration, is found. As metastases from Wilms' tumor are generally blood-borne, care should be taken in examining these patients not to palpate the tumor more than is absolutely necessary.

### DIAGNOSIS

Other abdominal tumors that may be encountered in children and lead to some confusion in differential diagnosis are medulloblastoma of the adrenals, retroperitoneal sarcoma, lymphosarcoma of the bowel, congenital abnormalities of the kidney, mesenteric and pancreatic cysts, and splenomegalia associated with leukemia or lymphoblastoma.

Complete radiographic and urologic examination of the urinary tract in these patients is definitely indicated. As they are generally young, a cystoscopy with retrograde pyelography is not always feasible. There are also cases in which the intravenous route for visualization of the renal pelves and calices is not technically possible. In these cases, differential diagnosis of Wilms' tumor may be carried out by intramuscular urography, using a 35 per

<sup>1</sup> Presented before the Radiological Society of North America, at the Twenty-eighth Annual Meeting, Chicago, Ill., Nov. 30-Dec. 4, 1942.

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well over 90 per cent. As to the type of treatment to be used in these cases, many differences of opinion still exist. Ladd and White (6 and 7), in a review of 60 cases, stress the importance of immediate surgery as soon as the diagnosis of a kidney tumor is established. Of their 60 cases, 14 were probably cured (operation had been performed too recently to determine the status of 4 cases). They believe that metastasis, if it does occur, will generally take place within two years. It is their conclusion that during the time required for administration of preoperative radiation and the waiting period for surgery, the chance of metastasis by way of the blood stream is very good. They also contend that shrinkage of the tumor is apt to force malignant cells into the blood stream. It is their opinion that, with proper preparation of the patient and with the transperitoneal approach, the chance of malignant cells being forced into the blood stream is negligible and the operative mortality is much less. They have treated some of their cases with postoperative roentgen therapy but as yet have insufficient data to permit evaluation of their results. Their records show that the size of the tumor had no relation to the ultimate outcome and there was no correlation of the tumor size with any predominant cell type or possibility of permanent cure.

In a series of 17 cases reported by Kretschmer and Hibbs (8), in which no preoperative roentgen therapy was administered, only one patient was living and well nine years after nephrectomy, the remaining 16 having died within six months following surgery.

Kretschmer (9 and 10) in a report of 10 cases, 8 of which had preoperative roentgen therapy, shows a survival of three years and four months for one child and two years and six months for another, following operation. Two of the 8 children that received preoperative roentgen therapy died before surgery could be undertaken, having sought medical attention too late. The 2 that did not receive preoperative roentgen therapy also died shortly

following operation. Basing his opinion upon these results, Kretschmer feels that the maximum benefit from preoperative roentgen therapy was noted in four to six weeks after its administration. It is his opinion that this is the ideal time for a nephrectomy and that postoperative irradiation should follow.

Soloway (11), in a review of 130 cases of renal tumor, of which 8 were Wilms' tumors, states that preoperative and postoperative deep x-ray therapy should be employed in all cases.

Priestley and Broders (12), in a review of 65 cases of Wilms' tumor, conclude that preoperative irradiation followed in three to six weeks by nephrectomy, with extensive postoperative irradiation, constitutes the method of choice in these patients.

Of the 4 cases to be reported here, one was treated by immediate nephrectomy with postoperative roentgen therapy; the other 3 received preoperative irradiation followed by transperitoneal nephrectomy and postoperative roentgen therapy. The patient who was not irradiated preoperatively died within four months following surgery, while the 3 who received preoperative and postoperative roentgen therapy combined with nephrectomy have all survived thus far. The survival periods following surgery in the 3 cases are four years and nine months, one year and ten months, and seven months. Recent examination of the last 2 patients shows no demonstrable signs of recurrence. It is somewhat early to determine what the ultimate outcome will be in these two cases. We believe, however, that the prognosis is probably good, since metastasis usually occurs early following surgery in patients with this type of tumor.

Preoperative roentgen therapy, in our opinion, should be used for the following reasons: (1) It reduces the size of the tumor and thus facilitates the operation, in the hands of most surgeons, so that there is a minimum amount of handling of the tumor, thereby keeping any malignant cells from being forced into the blood stream. (2) A certain amount of fibrosis is produced, which leads to a closing off of



Fig. 1. Case I: Right renal tumor with distortion of pelvis and calices.

a number of blood vessels, so that the tumor cells cannot be forced into the blood stream by handling. (3) It allows time for good physical preparation of the patient and assures better physical condition at the time of surgery. (4) It serves as a diagnostic aid, as these tumors are generally very radiosensitive.

Close co-operation between the radiologist and the urologist should be the watchword in these cases, so that the ideal time for surgery can be elected following the preoperative roentgen therapy. We believe that nephrectomy should follow irradiation in four to six weeks. A longer interval was allowed in one of the following cases, because of the poor physical condition of the patient and the slow regression of the tumor. There was also, in this case, a question of a pulmonary metastasis, which later proved to be a small area of infiltration due to an acute upper respiratory infection. Postoperative roentgen therapy we believe, should be given with-

in three to six weeks following surgery, or as soon as the condition of the patient will permit. Preoperative irradiation, in our opinion, based upon a review of the literature and upon our experience in this small series of cases, is much more important than postoperative.

#### TECHNIC

In this series a total of 3,500 to 4,000 r, measured with back-scatter, was administered to the tumor area through four or six ports, using 200,000 volts constant potential, Thoraeus A filtration, 50 cm. distance, 18 ma., H.V.L. 2.250 Cu.

#### CASE REPORTS

**CASE I:** L. H. (Ref. by A. D. M.): A white male, age 5, was admitted to the hospital Feb. 12, 1936, having first passed blood in the urine on Dec. 16, 1935. At that time he had a severe upper respiratory infection. Ten days later there was a recurrence of bleeding, which continued intermittently until admission. One week before hospitalization, a physician made a diagnosis of nephritis. On a second visit to the physician a tumor was discovered in the left flank and the child was referred to a urologist for consultation.

**Physical Examination:** There was a palpable hard mass in the right flank. Otherwise, the physical findings were not significant. Blood pressure, systolic 72; diastolic 50.

**Laboratory Examination:** Urinalysis, Feb. 12: acid, specific gravity 1.020, trace of albumin, sugar 0, acetone 0, diacetic 0, leukocytes 1 +, erythrocytes 3+. The red cell count was 4,070,000, hemoglobin 78 per cent, white cell count 8,900.

**X-Ray Examination** (Feb. 12, 1936): Intravenous urography showed distortion of the lower calices on the right with displacement of the kidney pelvis upward. A mass measuring 8 cm. in diameter was seen arising in the lower pole of the right kidney. Normal function and kidney outline were noted on the left (Fig. 1).

**Treatment:** Transperitoneal right nephrectomy was done on Feb. 13, the kidney pedicle being isolated, ligated, and amputated before manipulating the kidney. Postoperative roentgen therapy was given from March 17 to April 1, 1936, a total of 3,980 r, measured with back-scatter, being administered through two anterior and two posterior ports 10 cm. square, on the right. The factors were 200 kv. constant potential, 18 ma., Thoraeus C filter, 50 cm. distance, H.V.L. 3.50 Cu, 0.070 Å. effective wave length.

**Progress:** The patient made an uneventful recovery from operation and roentgen therapy.



Figs. 2 and 3. Case II: Right renal tumor with delayed function and distortion of pelvis and calices.

On Feb. 20 the surgeon made the following note: "On arms, trunk and legs are discrete hard nodules about the size of small grains of wheat. Mother states some of these have been in evidence for over a year, while others have made their appearance more recently. Must consider possibility of metastasis."

Roentgenographic examination of the chest, May 29, 1936, showed extensive infiltration of both lung fields, consistent with metastatic neoplasia.

Death occurred in July 1936.

*Gross Pathology:* The kidney measured  $12 \times 8 \times 5$  cm. There was a definite generalized enlargement of the lower pole. On palpation this region was soft and several small, rounded, somewhat yellowish discolored elevations were seen beneath the capsule, which was intact. The renal pelvis and the upper ureter were filled with clotted blood.

Cut section revealed a soft bulging tumor, 8 cm. in diameter, in the lower pole of the kidney. Fibrous connective-tissue strands were seen running through the surface of the tumor, and it was surrounded by what appeared to be a very distinct fibrous connective-tissue capsule. The lower half showed hemorrhagic degeneration which in some spots was almost gelatinous. There were also some distinct yellow irregular areas present. The kidney cortex surrounding the tumor was thin and in some areas completely destroyed. The upper pole of the kidney

showed little of note; there was considerable displacement of the kidney pelvis and upper calices.

*Microscopic Pathology:* The dominating feature of the tumor from a microscopic standpoint was the presence of large glandular areas made up of cells chiefly columnar in character and surrounded by rather thinly arranged spindle-like cells. The stroma of the tumor consisted of two types of cells. The predominating type was a collagen-producing cell containing relatively few nuclei. Large areas of necrosis were present. The pathologist was unable to find any definite striated muscle or definitely recognizable smooth muscle in the tumor. In this respect it departs somewhat from the usual microscopic picture. The other findings, however, are typical and perfectly diagnostic of the so-called Wilms' tumor of the kidney which appears in childhood and infancy.

CASE II: T. W. (Ref. by A. D. M.): A white child, age 8, was admitted to hospital Jan. 27, 1938, with a history of gross hematuria on Jan. 23, that had persisted until the time of admission. The patient had been in good health until that time except for a chronic otitis media of the right ear, of five or six years' duration. For the past year, there had been recurrent attacks of severe upper right abdominal pain after meals, attributed to an allergy for wheat.

*Physical Examination:* There was a mass in the



right kidney area, approximately twice the size of a normal kidney, palpable anteriorly and posteriorly. It moved with respiration, was firm in consistency, and was not tender.

*Laboratory Examination:* Red blood cells 4,060,000; hemoglobin 56 per cent; white cells 6,400 (polymorphonuclears 50 per cent; lymphocytes 50 per cent). Urinalysis: red, neutral, specific gravity 1.017, albumin 2+, sugar 0, acetone 1+, leukocytes 2+, erythrocytes 4+, no casts. Sedimentation time: 23 mm. in fifty minutes.

*X-Ray Examination:* The left kidney was normal in size, shape, and position, and urinary dynamics and anatomy were normal in the left upper urinary tract. The right kidney was twice normal size. Dye did not appear in the right kidney until after an interval of thirty minutes and there was no concrete outline of intrarenal structures (Fig. 2). In the region of the upper calix on the right a collection of dye appeared, about 2 cm. in diameter, with an irregular circular outline.

Retrograde pyelography, with cystoscopy, showed smoky urine coming from the right ureteral orifice. There was no difficulty in catheterization of the right ureter. The calices were not well outlined (Fig. 3).

X-ray examination of the chest was negative for metastases.

*Treatment:* Preoperative roentgen therapy was given from Jan. 30 to Feb. 15, 1938. A total of 4,000 r with back-scatter was administered through two anterior and two posterior ports 10 cm. square. The factors were: 200 kv. constant potential, 18 ma., Thoraeus A filtration, 50 cm. distance, H.V.L. 2.250 Cu, 0.101 Å. effective wave length.

At the time of admission to the hospital, for nephrectomy, the tumor was no longer palpable. A right nephrectomy was done March 8, using the transperitoneal approach, with early ligation of the pedicle followed by excision of the tumor.

Postoperative roentgen therapy was administered from April 11 to April 28, using the above technical factors and giving a total dosage of 3,300 r measured with back-scatter.

On Sept. 15, 1942, the patient remained well and in good health, with no signs of recurrence.

*Gross Pathology:* The kidney measured 8.5 × 4.5 × 3.0 cm. The lower pole showed thickening and a palpable firm area. On cut section the kidney appeared to be normal with the exception of an area in the lower pole measuring 1.5 cm. in diameter. This had a pale gray margin and a homogeneous yellow center. Projecting from this area into the lower calix and practically filling the lower half of the pelvis of the kidney was a soft, gelatinous mass of tissue about 3 cm. in diameter, which was obviously an extension of the tumor. The mucous membrane of the pelvis showed punctate hemorrhage surrounding the tumor.

*Microscopic Pathology:* A section of a regional lymph node from the hilar region of the kidney showed no evidence of tumor formation. The

tissue extending into the renal pelvis from the tumor showed necrosis and revealed no discernible cell structures. The mass of the tumor itself was composed largely of homogeneous tissue resembling connective tissue. A few remnants of tissue suggesting kidney tubules remained in this area. There were, however, small areas of tumor tissue still present, composed largely of foamy cells having rather dense nuclei. Marked irradiation changes are noted in these cells. Two separate pathological opinions were rendered. One was that this was a Wilms' tumor with changes due to irradiation; the other that it was the remains of a hypernephroma.

CASE III: L. M. (Ref. by Drs. H. B. M. and R. R.): A white male, age 3, was admitted to the hospital Oct. 17, 1940, having been apparently well until about two weeks previous to admission. During this time he had had intermittent mild abdominal pains. Three days previously he had fallen on his abdomen and complained of severe pain afterward. This was followed by vomiting, continued abdominal pain, loss of appetite, and failure to take fluids, from that time until hospitalization.

The child had been under the observation of a pediatrician since birth (Dr. R. R. R.). He was seen on April 14, 1940, and at that time the abdominal veins were prominent but no masses were discernible. Except for numerous upper respiratory infections in the past the history was not remarkable.

*Physical Examination:* Examination of the abdomen showed an asymmetrical fullness visible over the left side. There was a palpable, hard, smooth mass in the left abdomen extending to the mid-line medially, to the crest of the ilium inferiorly, and to the costal arch superiorly.

*X-Ray Examination* (Oct. 17, 1940): A warm barium clysis entered readily and filled the entire colon. The tumor in the left side compressed the descending colon but no lesions were demonstrable in the colonic tract. The descending colon was displaced anteriorly by a retroperitoneal mass (Fig. 4).

Preliminary radiographic examination of the abdomen on Oct. 18 showed the right kidney to be normal in size, shape, and position. On the left side was a large kidney-shaped mass extending from the costal margin downward across the crest of the ilium, homogenous in character and smooth in outline.

With the intravenous administration of diodrast the right kidney was well shown and function appeared good at all times. There was only suggestive evidence of the left kidney about the perimeter of the tumor (Fig. 5).

On Nov. 30, 1940, an area of increased density in the left lower lung field was diagnosed as a possible neoplasm. This had disappeared on Dec. 20.

Intravenous urography on Jan. 3, 1941, showed no changes in the right kidney. The left kidney showed evidence of increased function as compared to previous examination. The mass involving this kidney was one-half its previous size.



Figs. 4 and 5. Case III: Left renal tumor displacing the descending colon. The pyelogram (right) shows only slight renal function on the left.

**Laboratory Examination:** Successive blood counts were as follows: Oct. 17: red cells 3,210,000, hemoglobin 56 per cent, white cells 24,100. Oct. 24: red cells 4,010,000 hemoglobin 80 per cent, white cells 14,800. Nov. 2: red cells 3,860,000, hemoglobin 76 per cent, white cells 6,800.

Urine examination during the entire period of hospitalization showed nothing remarkable.

**Treatment:** Treatment during the first period of hospitalization consisted of small frequent transfusions, a total of 500 c.c. of blood being given in a period of four days, and preoperative roentgen therapy.

Roentgen therapy was administered to the left renal area through two anterior, two posterior, and two left lateral ports, 10 cm. square. The factors were: 200 kv. constant potential, 18 ma., Thoraeus A filter, 50 cm. distance, H.V.L. 2.250 Cu, 0.101 Å. A total of 3,500 roentgens measured with backscatter was administered to the tumor.

During hospitalization, Oct. 17 to Nov. 30, 1940, the temperature varied from 100.5° to 102° daily. Convalescence was slow. During the preoperative interval the patient had an upper respiratory infection and an area of consolidation in the left lower lobe was thought to be a metastasis but later this disappeared. Surgery was deferred because of the child's poor physical condition, until Jan. 10, 1941. Twelve days later, postoperative roentgen therapy was carried out in a similar manner and with the

same amount of radiation and the same technical factors as preoperatively.

**Operative Report** (Jan. 10, 1941): Through a transperitoneal approach, a left nephrectomy was done, the veins being ligated first. The tumor, which was adherent, was carefully dissected out, the artery being clamped later. The tumor extended across the mid-line and was firmly adherent to the aorta and vena cava and was attached by a very short pedicle.

Postoperative convalescence was not remarkable. Transfusions of citrated blood were given, 250 c.c. on two separate occasions.

**Gross Pathology:** The left kidney was about 50 per cent larger than a normal kidney. It fluctuated and released considerable fluid when opened. A strip of kidney tissue on the inner aspect of the poles was normal. The blood vessels and ureters were normal. A number of lumps of brownish necrotic tissue were present. The tissue was friable and soft on the inside at the pelvic region. Otherwise the interior was largely an empty space from which the fluid had been evacuated.

**Microscopic Pathology:** Several sections showed only necrosis, with no evidence of malignancy.

**Diagnosis:** Remains of probable Wilms' tumor, after irradiation.

The child remains well, with no signs of recurrence.

**CASE IV:** A. D. (Ref. by V. J. R.): A white female, age 8, was admitted to the hospital Feb. 2,



Fig. 6. Case IV: Left renal tumor with deformity of pelvis and calices.

1942, having been seen by her physician the day before admission. Her mother had noticed a mass in the left upper quadrant two or three days previously. She thought that the child had always had a protruding type of abdomen. There had been no apparent loss of weight. There was urinary frequency but no nocturia or gross hematuria. Occasionally in the past the child had complained of abdominal distress, especially after eating, but had had no other complaints.

**Physical Examination:** There was a hard circumscribed mass, approximately 10 cm. in diameter, in the left upper quadrant, that was movable and descended on deep inspiration.

**Laboratory Examination:** Urinalysis (Feb. 3, 1942) showed specific gravity 1.030, acid, slight trace of albumin, sugar 0; 10 white blood cells per high power field (centrifuged specimen); occasional red blood cell per high power field. The red blood cell count was 4,510,000; hemoglobin 83 per cent; white cells 5,900.

**X-Ray Examination** (Feb. 3, 1942): Roentgen examination of the chest revealed no signs of metastases. Preliminary examination of the urinary tract showed a large circumscribed mass on the left side, extending from the median line to the external borders and from just below the iliac crest to the left costal margin. The right kidney was normal in size, contour, and position. Intravenous urography showed normal kidney function on the right. On the left there was marked deformity of the pelvis

and the calices were not well demonstrated—characteristic of a new growth involving the left kidney (Fig. 6).

**Treatment:** Preoperatively a total of 3,900 r with back-scatter was delivered to the left renal area through two anterior, two posterior, and two lateral ports 10 cm. square, over a period of twelve days, Feb. 5 to Feb. 17, 1942. The factors were: 200 kv. constant potential, 50 cm. distance, 18 ma., H.V.L. 2.250 Cu, 0.101 Å., Thoraeus A filter.

On April 1, a left nephrectomy was performed, by the transperitoneal route, with ligation of the left renal vein and artery as soon as exposed. The tumor was well encapsulated, with very few adhesions.

From May 4 to May 14, inclusive, postoperative roentgen therapy was administered, with the above technical factors, giving a total dose of 3,700 r with back-scatter.

**Gross Pathology:** The left kidney measured 10.5 X 10.5 X 5 cm. The only normal appearing kidney tissue was located at the upper and lower poles. The entire central portion was composed of a mass bulging from the lateral aspect of the kidney and causing enlargement and distention of the organ.

On cut section the tumor was found to be fairly well circumscribed and surrounded by a fibrous capsule. The mass was quite soft in the central portion and had undergone hemorrhagic necrosis. The pelvis and ureter appeared to be entirely normal, with no evidence of invasion.

**Microscopic Pathology:** Sections of the kidney tumor showed it to be composed almost entirely of necrotic tissue. In recognizable areas of the remaining tumor tissue the appearance was that of a highly undifferentiated malignant nephroma of the Wilms type.

**Course of Treatment:** Roentgen therapy was started Feb. 5, 1942, preoperatively, with consequent reduction in size of the mass. Considerable toxicity was noted during this series of roentgen therapy, with elevation of temperature due to absorption. The blood reached a level of 53 per cent hemoglobin and 2,740,000 red blood cells. On hospitalization prior to nephrectomy, March 30, 1942, the hemoglobin was 84 per cent and the red blood count 4,690,000.

Convalescence postoperatively was uneventful.

On readmission, May 4, 1942, for postoperative therapy, the hemoglobin was 82 per cent and the red blood count 4,040,000. Radiographic examination of the general skeletal structures showed no evidence of metastasis. The further course was uneventful and the child is in apparently good health, with no signs of recurrence, at the present time.

## CONCLUSIONS

1. Four cases of renal tumor in children are presented, one of which was treated by surgery and postoperative irradiation and

the other three by preoperative irradiation, surgery, and postoperative irradiation. The first patient died within five months. The remaining three show, respectively, a survival of four years and nine months, two years, seven months.

2. Combined preoperative irradiation, surgery, and postoperative irradiation offer the most satisfactory method of treatment in these cases, in most hands.

3. Irradiation should be used as an adjunct to surgery, and not as the sole treatment, for this type of tumor.

4. Close co-operation between the radiologist, urologist, and the patient's parents should be the rule, so that the surgery is carried out at the proper time following the administration of the preoperative irradiation. The ideal time for operation is four to six weeks following the preoperative series of irradiation.

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#### BIBLIOGRAPHY

1. BRADLEY, J. EDMUND, AND PINCOFFS, M. C.: Association of Adeno-Myo-Sarcoma of the Kidney (Wilms' Tumor) with Arterial Hypertension. *Ann. Int. Med.* 11: 1613-1628, March 1938.
2. ADAMS, PAYSON S., AND HUNT, HOWARD B.: Differential Diagnosis of Wilms' Tumor Assisted by Intramuscular Urography. *J. Urol.* 42: 689-708, November, 1939.
3. DEAN, ARCHIE L., JR., AND PACK, GEORGE T.: Embryonal Adenosarcoma of the Kidney. *J. A. M. A.* 98: 10-17, Jan. 2, 1932.
4. EWING, JAMES: Neoplastic Diseases. Philadelphia, W. B. Saunders Co., 4th ed., 1940.
5. MCNEILL, WALTER H., JR., AND CHILKO, ALEXANDER J.: Status of Surgical and Irradiation Treatment of Wilms' Tumor and Report of Two Cases. *J. Urol.* 39: 287-302, March 1938.
6. LADD, WILLIAM E.: Embryoma of the Kidney (Wilms' Tumor). *Ann. Surg.* 108: 885-902, November 1938.
7. LADD, WILLIAM E., AND WHITE, ROBERT R.: Embryoma of the Kidney (Wilms' Tumor). *J. A. M. A.* 117: 1858-1863, Nov. 29, 1941.
8. KRETSCHMER, HERMAN L., AND HIBBS, WILLIAM G.: Mixed Tumors of the Kidney in Infancy and Childhood. *Surg., Gynec. & Obst.* 52: 1-25, January 1931.
9. KRETSCHMER, HERMAN L.: Malignant Tumors of the Kidney in Childhood. *J. Urol.* 39: 250-275, March 1938.
10. KRETSCHMER, HERMAN L.: Adenomyosarcoma of the Kidney (Wilms Tumor): Report of Three Cases. *Arch. Surg.* 41: 370-384, August 1940.
11. SOLOWAY, HERMAN M.: Renal Tumors: A Review of 130 Cases. *J. Urol.* 40: 477-490, October 1938.
12. PRIESTLEY, JAMES T., AND BRODERS, ALBERT C.: Wilms' Tumor: A Clinical and Pathologic Study. *J. Urol.* 33: 544-551, June 1935.

#### DISCUSSION

Herbert E. Landes, M.D. (Chicago): The kidney is probably the most frequent site of malignant neoplasms of infants and children. About 75 per cent of these tumors occur in children during the first five years of life. Since there are usually no characteristic symptoms until a palpable mass is accidentally discovered, the diagnosis is delayed, often until the tumor is considered to be in an advanced stage.

The warning sign of gross hematuria characteristic of kidney tumors of adults is not, as a rule, present in children, although in the authors' series there were two cases of hematuria. The only symptoms present generally are vague gastro-intestinal disturbances which in no way indicate disease of the kidney. A large, smooth, painless mass in the flank is often the initial sign of a dangerous and rapidly growing neoplasm. At this stage the diagnosis, of course, is not at all difficult. The history, physical findings, and urographic evidence are generally conclusive. While the authors have successfully relied upon excretion urography in 3 of their 4 cases, cystoscopy and retrograde urography will give more clear-cut diagnostic and differential diagnostic data. I would like especially to emphasize that no infant of either sex is too young for this procedure.

As has been stated, the presence of a smooth, firm mass in the flank of an infant or young child suggests the possibility of (1) kidney tumor, (2) adrenal tumor, (3) congenital anomalies of the kidney, including polycystic disease and hydronephrosis, (4) retroperitoneal sarcoma, (5) mesenteric cyst, (6) omental cyst, (7) enlargement of the spleen, (8) enlargement of the liver, and finally, very occasionally, (9) ovarian cyst. Visualization of the urinary tract accurately establishes the relationship of the mass to the kidney and ureter.

There is still some difference of opinion as to the most desirable plan of treatment. The high mortality proves that our present methods are unsatisfactory in the vast majority of cases. These tumors are rapidly growing metastasizing embryonal neoplasms and, as the authors have pointed out, neither the size of the tumor nor the histopathology is prognostic. Most of the tumors are radiosensitive to a high degree—a feature presented by all the authors' cases.

Nephrectomy, in combination with roentgen therapy, has now been generally accepted as offering some hope of permanent cure. The mortality seems to be slightly higher if either method is used alone. Preoperative roentgen therapy is, in my opinion, desirable for the reasons stated by the authors. The small number of cures of several years' duration, regardless of the treatment employed, is still discouraging. These tumors can generally be removed surgically, a transperitoneal approach being preferable. The probability of recurrence is, however, very great.

With the strides that have been made in roentgen therapy during the last few years and a closer co-operation between the roentgenologist and the urologist, we may hope for more satisfactory results in the near future.

Lt. Cmdr. J. Marshall Neely, M.C., U.S.N.R. (U. S. Naval Hospital, Great Lakes, Ill.): While Wilms' tumor is most commonly encountered during childhood, it is occasionally found in adults. The more common adult neoplasm, malignant nephroma of hypernephroma type, is even less commonly seen in children. Histologically Wilms' tumor is usually quite pure as to cell type, but occasionally one finds a case in which it is quite evident that a transition between this type of tumor and the hypernephroma type of malignant nephroma does exist. It seems likely that so-called Wilms' tumor must be considered as a clinical rather than a pathological entity and that the histological pattern considered as characteristic of the tumor in reality represents a point in differentiation in malignant nephromas in

general. It is also doubtful if Wilms' tumors are greatly more radiosensitive than hypernephromas except as would be expected in any tumor showing less differentiation.

The objection to preoperative irradiation in this group of tumors is the same as in tumors in general where biopsy information is not available. Surgical pathology following irradiation is always somewhat unreliable, and in those cases where no tumor cells can be found the accuracy of diagnosis must always be questioned.

Since there is no clinical or experimental evidence that biopsy is harmful, I do not believe that we, as radiologists, should use this as an argument for preoperative therapy. In many instances, however, as in some of the cases presented by Doctor Frazer, the diagnosis as evaluated by clinical and roentgen findings is so evident that there should be no hesitation in using preoperative irradiation. Here, simple reduction in tumor size is sufficient indication.

Doctor Frazer is to be congratulated on his excellent presentation.



# Urinary Tract Changes with Benign Pelvic Tumors<sup>1</sup>

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ALTHOUGH THE physiological alterations in the urinary tract which occur during pregnancy are well known to radiologists and clinicians, the secondary changes produced by pressure of benign pelvic tumors are not so widely recognized. Many benign pelvic tumors in women are capable of causing changes in the upper urinary tract. The recognition of the frequent occurrence of these alterations is important both to the pelvic surgeon and to the student of the ureter in pregnancy.

urography, they showed that 65.7 per cent of myomas and 81.9 per cent of ovarian cysts produced significant alterations in the upper urinary tract. The higher incidence of changes associated with ovarian cysts was explained on the basis of the soft consistency of the tumor and its ability to mold or compress the ureters at the brim of the true pelvis.

Since 1937, we have studied, by excretory urography, 96 adult female patients with benign pelvic tumors of various

TABLE I: EFFECT OF BENIGN PELVIC TUMORS UPON THE UPPER URINARY TRACT

	Myomata	Cysts	Myomata with Cysts	Total Cases
Number	77	14	5	96
Obstruction	39	3	4	46 (47.9%)
Displacement	11	1	0	12 (12.5%)
Both obstruction and displacement	6	2	0	8 (8.4%)
No effect	21 (27%)	8 (57%)	1 (20%)	30 (31.2%)

In 1935, Baker and Lewis (1) compared the alterations of the urinary tract occurring in pregnancy with those produced by pelvic tumors. Their series included 16 patients with pelvic tumors comparable in size to the pregnant uterus after the third month of gestation. In these patients the quantitative and qualitative alterations in the upper urinary tract were similar to those of pregnancy; a high degree of dilatation was observed in pregnancy, in large ovarian cysts, and in fibromyomas of the uterus. The changes were attributed largely to mechanical pressure.

Kretschmer and Kanter (3) found a high incidence of urinary changes in 51 female patients with benign pelvic tumors. By

sizes. Several months after the tumor was removed, another urographic study was done.<sup>2</sup> There were no clinical signs or symptoms of significant urinary tract disease in any of these patients. Thirty cubic centimeters of diodrast<sup>3</sup> were injected intravenously, and a minimum of four radiographic exposures made. These included a roentgenogram of the abdomen, one in the supine position five minutes after the injection, another in the Trendelenburg position at fifteen minutes, and one in the erect posture at twenty minutes.

Of the 96 patients in our series, 66 (68.7 per cent) showed roentgen evidence

<sup>1</sup> Presented before the Radiological Society of North America, at the Twenty-eighth Annual Meeting, Chicago, Ill., Nov. 30-Dec. 4, 1942.

<sup>2</sup> The intravenous urograms were made in the Department of Radiology at the Hospital of the University of Pennsylvania, under the direction of Dr. E. P. Pendergrass.

<sup>3</sup> Diodrast for this purpose was supplied through the generosity of the Winthrop Chemical Company.



Fig. 1. Large calcified myoma lying in the anterior portion of the abdomen above the pelvic inlet. There is no ureteral involvement.

TABLE III: EFFECT OF BENIGN PELVIC TUMORS UPON THE UPPER URINARY TRACT: POSITION OF TUMOR

	Freely Movable Tumor	Adherent or Impacted Tumor	Intra-ligamentous Tumor
Obstruction	7	27	12
Displacement	3	4	5
Both obstruction and displacement	0	4	4
No effect	19 (66%)	7 (17%)	4 (16%)
TOTAL	29	42	25

of abnormal effects in the urinary tract is presented in Table II. Fifty of the pelvic tumors were approximately 10 cm. in diameter, and 2 measured as much as 30 cm. Although the size of the tumor was important in producing pressure changes, there was no significant difference in the degree of dilatation produced by tumors greater than 10 cm. in diameter. The total number of the larger tumors is too small, however, to give reliable percentage figures. A huge multilocular cyst which contained 10 liters of fluid was found in one instance arising from the right ovary. This tumor extended high in the abdomen

TABLE II: EFFECT OF BENIGN PELVIC TUMORS UPON THE UPPER URINARY TRACT: SIZE OF THE TUMOR

Diameter →	10 Cm.	15 Cm.	20 Cm.	25 Cm.	30 Cm.
Number	50	29	12	3	2
Ureters affected	29 (58%)	24 (83%)	9 (75%)	3 (100%)	1 (50%)
Not affected	21 (42%)	5 (17%)	3 (25%)	0	1 (50%)

of ureteral obstruction, displacement, or both. Obstruction occurred in 46 (47.9 per cent), displacement in 12 (12.5 per cent), and both obstruction and displacement were present in 8 (8.7 per cent). Myomas of the uterus were encountered in 77 patients; 14 patients had ovarian cysts, and 5 had both a myoma and a cyst. Abnormal urographic changes were observed in 56 patients (72.5 per cent) with myomata, 6 (43 per cent) with ovarian cysts, and 4 (80 per cent) with both cyst and myoma (Table I). A correlation of the size of the tumor as found at operation and the incidence

and displaced the right kidney upward, but it did not produce an obstructive uropathy. In another patient with a large and partly calcified myoma which extended high above the level of the pelvic inlet, no ureteral changes were observed (Fig. 1). We believe that the position of the tumor in relation to the pelvic ureter is more important than its size. In our series, the impacted or the intraligamentous tumors produced the highest evidence of alterations in the urinary tract (Table III). In fact, it was unusual to find an intraligamentous cyst or fibroid

which did not produce abnormal manifestations (Fig. 2). We were unable to corroborate the observations of Kretschmer and Kanter, who showed that the cystic tumors produce a higher incidence of alteration of the urinary tract than the solid tumors.

What are the urinary tract lesions which one may expect as a result of mechanical pressure by a pelvic mass? From our experience in this series of patients, the changes seen on the urograms were qualitatively similar to those seen during

benign pelvic tumor. In no instance did we see complete absence of function of one kidney such as may occur with advanced malignant growth in the female pelvis.

Different degrees of delayed transportation were seen with different positions of the patient on the roentgenographic table. In some instances, with the patient in the supine or Trendelenburg, position, moderate dilatation of the upper ureters was easily demonstrable, but in the erect posture the upper ureters would empty and



Fig. 2. Intraligamentous cyst producing ureteral obstruction on the right side. This was the most severe obstruction seen in any of our patients.

pregnancy but were rarely so pronounced. Dilatation of the ureters, when present, was seen always at the level of the pelvic inlet or slightly above. This dilatation was usually bilateral, often producing greater changes on the right side (Fig. 3). In the more pronounced cases of obstruction, the ureters were widened, elongated, and redundant above the point of obstruction, and the renal pelvis and calices showed evidence of back pressure. In the milder cases, only the upper ureter showed moderate or slight dilatation. We have observed but one patient who had a severe degree of hydronephrosis as a result of a

the renal pelves and calices would return to normal appearance. When, however, the tumor was fixed within the pelvis, the obstructive phenomena were more pronounced and persistent in all positions.

Displacement of the pelvic portion of the ureter, when present, was most often lateral. In only a few instances was the pelvic ureter straightened in a vertical direction by the mass, which appeared to fix it in position.

One of the most interesting phases of this investigation proved to be the comparison of the preoperative and postoperative urograms. The latter were made





Fig. 3. Mild obstructive uropathy produced by myoma uteri. The right ureter is dilated and elongated above the iliac vessels. The pelvis and calices are normal.

from eight to sixteen weeks after operation. In all instances a return to normal function was demonstrated. Continued comparison of the two sets of films frequently brought out minor preoperative changes that might well have been overlooked. One striking feature of the follow-up urograms was their poor diagnostic quality for morphological changes, compared to the preoperative films. Without the pelvic mass the transportation of dye was rapid, and recording of filling of the renal pelves and calices was consequently often not obtained. This lends emphasis to the statement that the anatomical outlines of the *normal* urinary tract are frequently the most difficult to demonstrate by excretory urography.

It is not within the scope of this paper to discuss the urinary tract changes which occur with pregnancy. Excellent publications of Hundley *et al.* (2), of van Wageningen and Jenkins (5), of Lee and Mengert (4),

and many others, have indicated the important role of hormones in the production of such changes. Microscopic studies show definite alterations in the ureters during pregnancy. Ureteral changes similar to those in pregnancy, but somewhat less pronounced, were observed on urographic examination in 96 cases of benign pelvic tumor in non-pregnant women. The development of these changes in the absence of the hormonal stimulation of pregnancy indicates that external pressure is capable of producing them and suggests that pressure must play an important role in the dilatation that occurs in the pregnant woman.

In this series the urographic findings gave no lead as to the type of pelvic tumor. A number of instances of early malignant change in myomata or ovarian cysts were met. While they were excluded from this group, survey of the urograms shows nothing distinctive. On the other hand, extensive malignant growths in the pelvis, particularly of cervical origin, are recognized as frequently influencing ureteral function. Absence of function of one kidney in association with a pelvic tumor is indicative of extensive malignant growth, while simple displacement or partial blockage, although it does not refute the presence of an early malignant neoplasm, is more likely to result from a benign pelvic tumor.

#### CONCLUSIONS

Ninety-six patients with benign pelvic tumors were studied by excretory urography before and after removal of the tumors.

Urinary tract changes—obstruction, displacement, or both—were present in 66 patients. These changes are discussed in relation to the type, size, and position of the tumor and the position of the patient at the time of the examination.

All of the changes disappeared completely following removal of the tumors.

There is evidence that pregnancy changes in the urinary tract are partly due to mechanical pressure.

Excretory urography is a valuable preoperative study in all patients with benign pelvic tumors.

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#### BIBLIOGRAPHY

1. BAKER, E. C., AND LEWIS, J. S., JR.: Comparison of the Urinary Tract in Pregnancy and Pelvic Tumors. *J. A. M. A.* 104: 812-815, March 9, 1935.
2. HUNDLEY, J. M., JR., SIEGEL, I. A., HACHTEL, F. W., AND DUMLER, J. C.: Some Physiological and Pathological Observations on the Urinary Tract During Pregnancy. *Surg., Gynec. & Obst.* 66: 360-379, Feb. 15, 1938.
3. KRETSCHMER, H. L., AND KANTER, A. E.: Effect of Certain Gynecologic Lesions on the Upper Urinary Tract: Pyelographic Study. *J. A. M. A.* 109: 1097-1101, Oct. 2, 1937.
4. LEE, H. P., AND MENGERT, W. F.: Effect of Pregnancy on the Urinary Tract. *J. A. M. A.* 102: 102-107, Jan. 13, 1934.
5. VAN WAGENEN, G., AND JENKINS, R. H.: Experimental Examination of Factors Causing Ureteral Dilatation of Pregnancy. *J. Urol.* 42: 1010-1020, December 1939.

#### DISCUSSION

George H. Gardner, M.D. (Chicago, Ill.): Doctors Payne and Chamberlin have presented further evidence that benign tumors of the female genital organs may be accompanied by disturbances in the ureters—either dilatation or distortion or both. Obviously these ureteral changes are due to mechanical pressure by the tumors on the ureters. One would expect, therefore, to find the highest incidence as well as the most marked degree of ureteral dilatation and distortion in association with broad ligament tumors and those which are incarcerated in the pelvis.

It is amazing that the authors encountered such a high percentage of ureteral changes—70 per cent—in their series of 96 women with uterine fibroids and ovarian cysts. These findings, however, are chiefly of academic interest, since their patients did not present either signs or symptoms of urinary tract disease, and all of the postoperative urograms revealed a return of the ureters to normal. Furthermore, you as radiologists might disagree with the authors in their diagnosis of ureteral dilatation in some of the borderline preoperative urograms. At any rate, clinicians recognize a considerable latitude both in the diameter of the normal ureter and in the radiologist's interpretation of urograms.

I wish that the authors had commented on the parity of their patients, since they state that their findings are qualitatively comparable to the changes which occur during pregnancy. It seems likely that a multiparous woman with a pelvic tumor would be more likely to show urographic evidence of ureteral dilatation than a nulliparous woman with a similar tumor. I have never been certain that the ureteral changes of pregnancy always disappear

completely after the puerperium. It seems probable that there is sometimes slight residual atony of the ureters. This might be increased with each subsequent full-term pregnancy. In consequence, multiparae would be more likely to present ureteral dilatation with lesser degrees of pressure by pelvic tumors.

It would have been of interest to have had a description of the preoperative cystograms in these cases. Undoubtedly the bladder is frequently both displaced and distorted by uterine fibroids. At any rate, I can conceive of situations in which pressure by subvesical fibroids might lead to ureteral dilatation.

I wish, also, that the authors had reported about their patients' blood pressure before and after operation. It would be significant if the woman with hypertension were shown to have a lower pressure after removal of her tumor and return of the ureters to normal.

Finally, I doubt that intravenous urography is of momentous value as a preoperative procedure in women with large incarcerated or intraligamentary tumors. Too often that portion of the ureter which is compressed or displaced and thus might be injured during the operation does not appear in the urogram. There are more effective methods of demonstrating the exact location of a ureter, as by stereoscopic study of retrograde pyelo-ureterograms or by leaving ureteral catheters in place so that they can be palpated during operation.

The operator who is so cautious that he requests preoperative urography rarely traumatizes a ureter at the operating table. He knows that certain types of benign tumors tend to displace the ureter and he identifies this gynecologic *bête noire* before removing the tumor.

Doctor Chamberlin (*closing*): I want to thank Doctor Gardner for his excellent discussion. He certainly lost no time in finding our weak spots. We do not have any data on the parity of these patients and I quite agree with him that this would be interesting. Most of them, I believe, were multiparae, but the urograms following the removal of the tumor failed to show any evidence of multiparity or of any abnormal physiology—at least so far as we have observed—in the urinary tract.

The question of pressure on the bladder Doctor Payne felt was not really important, so that was not included in the paper.

In a few of our cases the lower ureter was fixed in a straight line rather than rounded in the lateral direction by a fixed intraligamentous mass in the pelvis, but in most cases the lower ureter was displaced.

It is quite true that the weakness of this method is that in many cases where an intraligamentous or incarcerated tumor is present in the pelvis, the lower ureter cannot be identified, but if it can be, Doctor Payne feels that the roentgenogram is of great assistance to him in the operating room.

# Entero-Enteric Intussusception<sup>1</sup>

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USE OF THE roentgen rays as an aid in the diagnosis of intussusception was first reported by Ladd in 1913. Shortly thereafter, in 1914, other reports by Lehmann and by Groedel appeared in the literature. Since that time excellent articles on the subject have been written by Davis and Parker, Sussman, Kirsner and Miller, and Ochsner and Gatch. For the most part these reports have dealt with the colocolic and ileocolic types of intussusception, and have described their roentgenologic characteristics as encountered during administration of a barium enema. It is the purpose of the present report to call attention to the roentgenologic characteristics of the entero-enteric type of intussusception as demonstrated after the administration of barium suspension by mouth.

Intussusception can be divided into colocolic, ileocolic (including ileocecal), and entero-enteric types according as it involves the colon, the ileum and colon in the region of the ileocecal valve, or the small intestine alone. Freilich and Coe, who reviewed 3,284 cases of intussusception, found that the entero-enteric type accounted for only 14 per cent of the total number. The most common type, ileocolic, is seen most often among infants less than two years of age and usually is characterized by a sudden onset (12). Entero-enteric intussusception, on the other hand, is frequently a disease of adult life and often is chronic in nature.

Although there are isolated reports in the literature (13) of spontaneous intussusception of the small intestine among adults, in the majority of instances some underlying lesion is present. The most common cause is tumor, either benign or malignant. In a third of 300 cases of intussusception in adults, collected from the

literature by Eliot and Corscaden, tumor was the exciting factor. Invagination of Meckel's diverticulum is next in frequency, a point emphasized by Harkins, who collected reports of 160 cases from the literature. Among other lesions which have been reported are enlargement of a mesenteric lymph node (10), ulceration of a Peyer's patch, stenosis, and adhesions (2).

Whereas the symptomatology of acute ileocolic intussusception occurring in infancy usually is characteristic, that of the chronic entero-enteric type in an adult frequently is atypical and bizarre. Wangensteen, in discussing the diagnosis of this condition, stated that "it is just in this type [entero-enteric] that help is most needed; for the appearance of blood in the stool is a late occurrence, and the tumors being small are often not palpated."

As has been pointed out by many observers (1, 7, 11, 14), when intussusception is encountered during the administration of a barium enema, several characteristic features are noted. Obstruction to retrograde filling is almost always met, but the site of obstruction may recede in the face of the advancing enema (Fig. 1). A mass which coincides with the site of obstruction and which recedes with it is frequently palpable. After evacuation of the enema, the mass and the site of obstruction may be found to have advanced again. This change in position is due to the fact that intussusception tends to be reduced and to recur as a result of the action of peristalsis and of the changing pressures within the bowel.

At the site of obstruction a filling defect is seen which has been variously named "cupola effect," "pincer effect," "inverted U," "beak effect," and "spiral sheath" (Fig. 2). These names all describe stages of the same phenomenon, namely, the filling with barium of the space between the

<sup>1</sup> Presented before the Radiological Society of North America, at the Twenty-eighth Annual Meeting, Chicago, Ill., Nov. 30-Dec. 4, 1942.

receiving layer of bowel (intussusciens) and the invaginated portion (intussusceptum). The amount of filling is regulated by the differential in pressure between the forces of the enema and the swelling and edema of the two layers of bowel. Sometimes the opaque material proceeds through the narrow channel of the invaginated portion and fills the normal bowel orad to the lesion. More often this does not take place unless intussusception has been completely reduced by the pressure of the enema.



Fig. 1. Ileocolic intussusception caused by myxoma of the ileum. Obstruction to the barium enema is encountered in the region of the transverse colon. At the time of roentgenoscopic examination the site of obstruction was seen to recede for a short distance toward the hepatic flexure.

When intussusception is approached from the end of the intussusceptum (and in most instances this is accomplished by means of a barium suspension given by mouth), different roentgenologic characteristics are noted. Obstruction in some degree is always present. Usually, this takes the form of a gradual narrowing of the lumen of the bowel without interference with the normal mucosal pattern until the intussusceptum is reached (Fig. 3a and b).



Fig. 2. Ileocolic intussusception (same lesion as that shown in Fig. 1) after evacuation of the enema. The characteristic "cupola" or "pincer effect" is well shown.

Here the channel narrows to an extent dependent upon the amount of swelling and edema in the involved tissues. In the patient who has complete obstruction this channel may be occluded. More frequently it is a few millimeters in diameter.

Usually, a mass is palpable at the site of obstruction, just as in the case of an intussusception encountered during examination by means of a barium enema. This mass, however, less frequently recedes in front of the advancing column and seldom recurs if the intussusception is reduced during the course of the examination.

As the column of barium advances and after it has proceeded through the narrow channel of the intussusceptum, it may be seen to widen out into the normal portion of bowel. At the same time some of the opaque material passes in a retrograde manner into the space between the walls of the intussusceptum and the intussusciens. This results in formation of the



Fig. 3. Case 1: *a.* Entero-enteric intussusception caused by an invaginated Meckel's diverticulum; the lumen of the ileum narrows as the intussusceptum is approached. *b.* Diagram showing the mechanism of intussusception. The shaded areas represent barium within the lumen of the bowel.

"spiral sheath" or "concentric ring" appearance (Fig. 4*a*), which is the end stage of the "pincer effect" described by various authors (1, 11, 14) dealing with examination by means of the enema.

In some instances, barium cannot be seen to fill the narrow channel of the intussusceptum, in which case the diagnosis is dependent upon recognition of the initial narrowing of the stream and the abrupt demarcation of the "spiral sheath." The diameter of this sheath is always considerably larger than the diameter of the lumen of the bowel as it approaches the sheath.

Since in most cases entero-enteric intussusception occurs as the result of some exciting factor, it would be advantageous to be able to recognize the underlying cause by means of the roentgenologic examination. Experience has shown, however, that this goal is seldom attained. In most instances, when a diagnosis of entero-enteric

intussusception is reached as a result of roentgenoscopic or roentgenographic observation, the causative factor remains obscure. Infrequently the examiner may recognize not only the intussusception but also the primary lesion.

Reports follow of three cases in which the roentgenologic observations were typical of entero-enteric intussusception. In each instance the diagnosis was reached before operation, and in each the barium suspension was given by mouth. Case 1 and Case 2 have been reported before (4).

#### REPORT OF CASES

**CASE 1:** A man 31 years old complained of intermittent cramping pains in the upper portion of the abdomen. He had first noticed the pain four months previous to examination and he believed that it was becoming progressively more severe. The pain extended toward the left side and was worse an hour after meals. Two months before registration the patient had passed a large, dark stool. On several occasions fresh blood had been observed in the stools. During the four months of illness there had been a weight loss of 25 pounds (11 kg.). Except for detection of slight epigastric tenderness, results of the physical examination were not remarkable. No masses were felt. Laboratory tests revealed severe anemia (2,780,000 erythrocytes per cubic millimeter and 8.4 gm. of hemoglobin per 100 c.c. of blood).

Results of roentgenologic examination of the colon were negative for pathologic processes. Roentgen examination of the small intestine by means of the opaque meal disclosed intussusception in the ileum about 2 feet (61 cm.) from the ileocecal valve (Fig. 3*a* and *b*).

Surgical exploration by Dr. J. deJ. Pemberton showed the intussusception to involve about 2 feet (61 cm.) of ileum and to be the result of an invaginated Meckel's diverticulum which contained atypical gastric mucosa. The intussusception was reduced, the diverticulum was removed, and lateral anastomosis was done.

**CASE 2:** A man 61 years old was examined on Jan. 24, 1941. He had been seen twice before, in 1929 and in 1930, and on the latter occasion cholecystectomy had been performed because of gallstones. He had been well since that operation until six months before his most recent registration, at which time he complained of pyrosis and flatulence, which were most severe three or four hours after meals. In October 1940, he had passed a black, tarry stool, an incident which had been followed six weeks later by midabdominal pain. His home physician had found him to be anemic and had discovered occult blood in the stools. There had been a

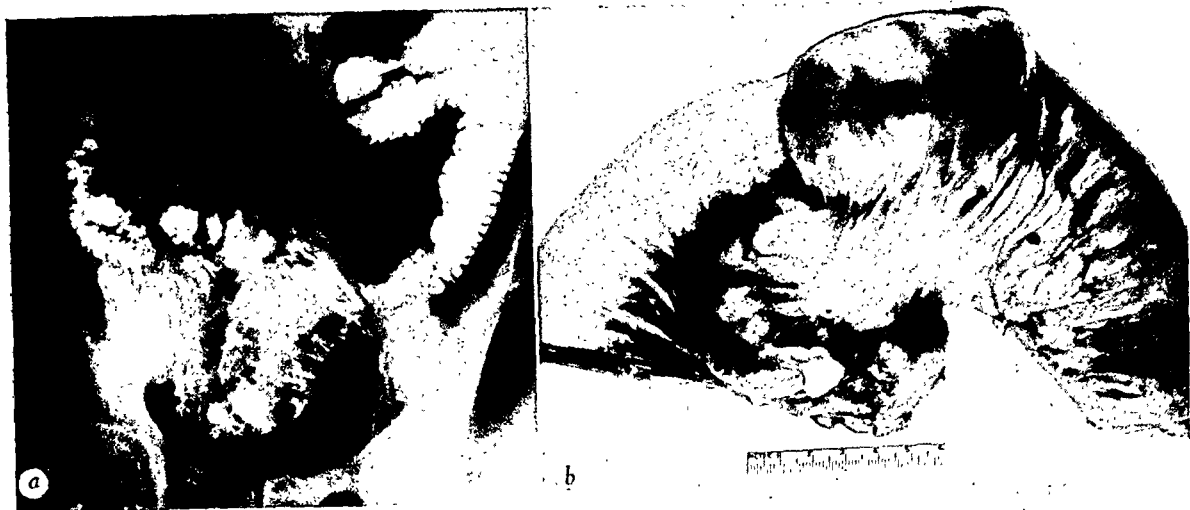


Fig. 4. Case 2: *a*. Entero-enteric intussusception caused by an adenocarcinoma of the jejunum; the "spiral sheath" or "concentric ring" appearance is well shown, as is the narrow channel through the intussusceptum. *b*. Removed segment of jejunum with mesentery.



Fig. 5. Case 3: *a*. Entero-enteric intussusception caused by leiomyosarcoma; the "concentric ring" appearance and the difference in diameter between the involved and uninvolved jejunum are characteristic. *b*. "Spot" radiograph of the lesion.

weight loss of 3 pounds (about 1 kg.). Pallor, epigastric tenderness, and a pulsating, tender mass in the lower part of the abdomen were noted on physical examination. Laboratory tests revealed microcytic hypochromic anemia (3,160,000 erythrocytes per cubic millimeter and 7.6 gm. of hemoglobin per 100 c.c. of blood) caused by chronic loss of blood.

Roentgenologic examination showed the stomach and colon to be normal. On roentgenoscopic observation of the small intestine after ingestion of a barium meal, intussusception was found in the jejunum about 2 feet (61 cm.) from the ligament of Treitz (Fig. 4*a*). This lesion corresponded to the movable mass palpated in the abdomen.

Surgical exploration by Dr. V. S. Ccunseller showed an adenocarcinoma to be present in the jejunum about 2 feet (61 cm.) from the ligament of Treitz, with involvement of the regional mesenteric lymph nodes (Fig. 4*b*). The tumor had caused intussusception of 6 cm. of bowel. Resection and end-to-end anastomosis were performed.

CASE 3: A man 57 years old complained of weakness and indigestion. For one year he had experienced mild pain and a sensation of fullness in the epigastric region. On several occasions he had passed tarry stools, and his family physician had found him to be anemic. On physical examination the only finding of significance was pallor. No



Fig. 6. Case 3: Removed segment of jejunum showing both the intraluminal and extraluminal portions of the dumbbell-shaped leiomyosarcoma seen roentgenologically in Fig. 5a and b.

masses were felt. Laboratory tests revealed a microcytic hypochromic anemia (2,060,000 erythrocytes per cubic millimeter and 4.7 gm. of hemoglobin per 100 c.c. of blood). Occult blood was present in the feces.

Roentgenologic examination showed the esophagus, stomach, and colon to be normal. A lesion was found on roentgenoscopic examination of the small intestine (Fig. 5a and b). The roentgenologic report was: "Intussuscepting lesion in upper jejunum. This is undoubtedly tumor with associated intussusception."

At surgical exploration Dr. Waltman Walters found a dumbbell-shaped tumor of the jejunum, which he removed (Fig. 6). The pathologist's report was "Grade 1 leiomyosarcoma in a leiomyoma (7 X 6.5 X 4 cm.) arranged in a dumbbell shape with the submucous and subserous prolongation of the neoplasm connected by a constricted mid-portion extending through the jejunal wall." At the time of operation intussusception was not noted.

#### CONCLUSIONS

1. Although entero-enteric intussusception occurs less frequently than other types,

its recognition by the roentgenologist is of greater value than his recognition of the others since the clinical signs are not often diagnostic.

2. The chief roentgenologic characteristics of this condition, when encountered during the course of examination after the administration of a barium suspension by mouth, are: (1) gradual narrowing of the lumen of the bowel as it approaches the intussusception; (2) marked narrowing of the lumen through the intussusceptum; (3) retrograde filling of the space between the intussusceptum and the intussusciens, with formation of a characteristic "concentric ring" or "spiral sheath" appearance; (4) a palpable mass coincident with a filling defect in the barium column.

3. Entero-enteric intussusception usually is secondary to some other lesion of the bowel, but the roentgenologist is seldom able to identify this lesion even after he has recognized the intussusception.

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#### REFERENCES

1. DAVIS, K. S., AND PARKER, CARL: Intussusception: Its Roentgenographic Diagnosis; Report of Cases. *California & West. Med.* 31: 330-335, November 1929.
2. ELIOT, ELLSWORTH, JR., AND CORSCADEN, J. A.: Intussusception, with Special Reference to Adults. *Ann. Surg.* 53: 169-222, February 1911.
3. FREILICH, E. B., AND COE, G. C.: Jejunal Intussusception. *Ann. Surg.* 105: 183-191, February 1937.
4. GOOD, C. A.: Chronic Intussusception of the Small Intestine: Three Cases in Which Diagnosis was Established by Roentgenologic Methods. *Proc. Staff Meet., Mayo Clin.* 16: 324-328, May 21, 1941.
5. GROEDEL, F. M.: Die Invaginatio ileocaecalis im Röntgenbild. *Fortschr. a. d. Geb. d. Röntgenstrahlen* 22: 206-208, 1914-15.
6. HARKINS, H. N.: Intussusception Due to Invaginated Meckel's Diverticulum: Report of Two Cases with a Study of 160 Cases Collected from the Literature. *Ann. Surg.* 98: 1070-1095, December 1933.
7. KIRSNER, J. B., AND MILLER, J. F.: Roentgen Diagnosis of Intussusception. *Radiology* 31: 658-669, December 1938.
8. LADD, W. E.: Progress in the Diagnosis and Treatment of Intussusception. *Boston M. & S. J.* 168: 542-544, April 10, 1913.
9. LEHMANN, C.: Ein Fall von Invaginatio ileocaecalis im Röntgenbilde. *Fortschr. a. d. Geb. d. Röntgenstrahlen* 21: 561-562, 1914.
10. MARR, N. G., AND MARXER, O. A.: Intussusception of the Jejunum. *Lancet* 2: 392-393, Aug. 20, 1932.

11. OCHSNER, H. C., AND GATCH, W. D.: Intussusception in the Adult. A Case Report. *Am. J. Roentgenol.* 42: 276-279, August 1939.
12. PERRIN, W. S., AND LINDSAY, E. C.: Intussusception: A Monograph Based on 400 Cases. *Brit. J. Surg.* 9: 46-71, 1921-22.
13. RYAN, T. F. J., AND MORGAN, J. W. P.: Acute Primary Intussusception of the Jejunum. *Brit. M. J.* 1: 613-614, March 25, 1939.
14. SUSSMAN, M. L.: Roentgenologic Aspect of Subacute and Chronic Intestinal Intussusception. *Am. J. Roentgenol.* 27: 373-382, March 1932.
15. WANGENSTEEN, O. H.: *Intestinal Obstructions*. Ed. 2, Springfield, Ill., Charles C Thomas, 1942, p. 405.

### DISCUSSION

Grant H. Laing, M.D. (Chicago): There are three points that I would like to make in connection with Doctor Good's paper. One is impressed in reviewing these cases by the periodicity of attacks and wonders if these recurrent episodes do not represent "minor intussusceptions." In such instances after the acute episode the bowel resumes its normal position, and when the patient gets to the roentgenologist he finds no definite evidence of intussusception.

The second point that I want to make is in connection with edema. Doctor Good brings out the fact that there is a narrowing of the intussusceptum. This narrowing is probably accounted for in great measure by the edema. So that if there is a large amount of edema there may be marked narrowing and the symptoms are those of obstruction. Thus it would be very difficult for the roentgenologist to tell whether he had an intussusception or not, and he would make a diagnosis of an acute obstruction in these cases.

The third point is hemorrhage. We teach, and we have been taught, that bright red blood ordinarily

comes from low down in the gastro-intestinal tract and that dark blood or tarry stools come from higher up. This is the usual thing; but in some of these cases, and one especially shown by Doctor Good, there is bright red blood coming from rather high in the tract. With the irritability that occurs in the intestine at this time, relatively small amounts of blood can be shunted from high up in the gastro-intestinal tract and still be bright red. In these cases the bleeding is not due to gross ulceration but is the result of capillary hemorrhage, and thus the clinician especially must not think necessarily of the pathology being low down because there is bright red blood in the stools.

If we are to have any progress in the refinements of diagnosis, there must be closer co-operation between the clinician and roentgenologist, and after hearing such a paper as Doctor Good's, we can certainly feel that we have gone far in this direction.

Doctor Good (*closing*): I should like to bring up one point which has not been covered, namely, the danger of giving barium by mouth to a patient suffering from intestinal obstruction. As a general rule, it is safe to give barium orally if there is no obstructing lesion in the colon. If an obstruction is present in the small intestine, the barium may be removed by suction. However, barium impacted behind an obstructing lesion of the colon cannot be reached by the suction tube and occasionally perforation of the cecum will take place.

It is a good practice, therefore, to examine the colon by means of a barium enema before attempting to study the small intestine. In the event the colon shows no lesion, examination of the small intestine may be carried out with relatively slight risk.





# Dyschezia and Megacolon<sup>1</sup>

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**T**HIRTY-THREE years ago I suggested that all cases of constipation could be separated into two groups: (1) colonic constipation, in which the passage through the colon is delayed, and (2) dyschezia (*δυσ*) difficult; *χέζω*, I go to stool), in which the faeces reach the rectum at the normal rate but their final evacuation is delayed owing to inefficient defaecation. Since that time the concept of dyschezia has become almost universally accepted, so that it was something of a surprise to read in the December 1941 issue of *RADIOLOGY* a paper by Delano, Ronayne, and Boland entitled "Rectal Dyschezia: A Misnomer for Megarectum." Although they regard the term dyschezia as "inept" and "obsolescent" and add that they have probed for diagnostic criteria or notes on etiology, it would appear that they have not read a single one of the numerous papers which have been written on the subject since the original publication of my monograph on *Constipation* in 1909. There had, in fact, never been any confusion between dyschezia and megacolon until the paper by Delano and his colleagues appeared.<sup>2</sup>

In 1919 I pointed out the similarity between megacolon and megaesophagus and suggested that the former is a result of achalasia (absence of relaxation) of the anal sphincter secondary to disease of Auerbach's (myenteric) plexus (Hurst, 1936), a view which has been confirmed by all recent writers on the subject.

I propose here to give a short account of both dyschezia and megacolon.

## DYSCHESZIA

Normal defaecation depends on a conditioned reflex. An infant is trained to open his bowels when he is put on a cham-

ber, no mental process being concerned in the act. In the course of time an elaborate conditioned reflex develops, in which getting up, a bath, dressing, breakfast, and finally sitting down with a newspaper and a pipe in the familiar w.c. take part. As a result of this, a strong mass peristaltic wave passes along the colon, and the feces which have collected in the pelvic colon enter the rectum, which has been empty since the last act of defaecation. The consequent distention of the rectum gives rise to the perineal sensation which constitutes the "call to defaecate." The diaphragm and abdominal wall are then voluntarily contracted, and the rise in pressure within the rectum calls forth the final reflex, which results in contraction of the rectum and relaxation of the anal sphincter, through which the faeces are evacuated.

Many cases of constipation formerly regarded as colonic are caused by inefficiency of the conditioned reflex, which should result in the partial evacuation of the contents of the proximal part of the colon into the pelvic colon as well as of the contents of the pelvic colon into the rectum. In most cases of dyschezia this conditioned reflex is unimpaired, but for various reasons it is not followed by the defaecation reflex proper, in which the rectum contracts and the anal sphincter relaxes, so that the rectum is found to be packed with faeces at whatever hour it is examined. Dyschezia often originates in neglect to respond to the call to defaecate, owing to laziness, insanitary conditions, or false modesty. The double reflex becomes progressively impaired. The rectum dilates so that an increasing quantity of faeces is required to attain the adequate internal pressure necessary to produce the call to defaecate, and finally the sensation is lost completely. The patient, however, is still capable of emptying his rectum if he tries, but by

<sup>1</sup> Accepted for publication in June 1943.

<sup>2</sup> An opportunity has been given Dr. Delano to defend his position. See page 190.—Ed.

this time he has generally convinced himself that he cannot get his bowels opened unless he takes a sufficient dose of aperient to produce fluid faeces which require no effort for evacuation.

Dyschezia may also result from weakness of the voluntary muscles of defaecation, assumption of an unsuitable posture during defaecation, and voluntary inhibition from fear of pain in diseases of the anal canal. But whatever the primary cause, the final result is the same. The defaecation reflex is lost, and incomplete evacuation results in the accumulation of faeces in the rectum.

*Symptoms:* In dyschezia the retention of solid faeces in the rectum, which is normally empty except immediately before defaecation, may give rise to a number of reflex symptoms, such as headache and general malaise, which disappear directly the bowels are opened. The instantaneous relief proves that these symptoms are not caused by auto-intoxication. Moreover, experimental distention of the rectum with a large plug of wool produces identical symptoms. Pressure on the surrounding parts by the retained faeces also gives rise to perineal discomfort. Pressure on the haemorrhoidal veins may be the exciting cause of haemorrhoids, and the passage of large hard scybala through the anal canal may produce an anal ulcer.

The irritation of the mucous membrane of the pelvic colon and rectum when hard faeces are retained for long periods gives rise to excessive secretion of mucus. This is the normal response of the healthy mucous membrane to mechanical irritation and is the result of a protective reflex. Under such conditions a diagnosis of "mucous colitis" has no justification, as proctoscopy reveals a healthy mucous membrane and the mucus contains no inflammatory cells.

*Diagnosis:* Before a self-made diagnosis of constipation can be accepted, it is necessary to ascertain what happens to the patient under natural conditions, for the majority consult a doctor only after they have begun to treat themselves with aperients. They regard themselves as consti-

pated because they take aperients, though frequently their bowels would act sufficiently without artificial aid. The patient should therefore be instructed to take no aperient and to make an effort to open his bowels every morning after breakfast, even if he feels no inclination to do so. He generally succeeds and it is then clear that he is not constipated at all and that both the local and general symptoms of which he complains are the result of purgation. If, on the other hand, the bowels are not opened, the abdomen and rectum should be re-examined: an empty colon and a full rectum indicate the presence of uncomplicated dyschezia. If the rectum is empty and hard scybala can be felt in the pelvic colon through the anterior rectal wall, pelvic colon dyschezia is present.

In severe cases the diagnosis should be confirmed and amplified by an x-ray examination, carried out after an opaque meal while the patient is taking no aperient. In dyschezia the passage through the colon is found to be at the normal rate or even more rapid than normal, all the barium collecting in the rectum or rectum and pelvic colon in twenty-four hours.

*Treatment:* Dyschezia can be cured by restoring to activity the defaecation reflex, which has been allowed to become inefficient by neglect and by interference with its normal performance by the habitual use of aperients. A simple explanation of the physiology of defaecation and encouragement are often all that is required, but it may be necessary to reduce the work the muscles of defaecation have to perform by giving liquid paraffin or an unabsorbable vegetable mucilage to increase the bulk and soften the faeces, together with a diet containing plenty of fruit and green vegetables.

When the patient is quite unable to evacuate the rectum although it is loaded with faeces, an enema of one fluid ounce of glycerine should be given in the morning after an unsuccessful effort has been made. The strength of the enema should be gradually reduced by replacing one fluid drachm of glycerine by water every other day until

only water is used. By this time the normal defaecation reflex and with it the tone and contractile power of the rectum have almost invariably returned.

#### MEGACOLON

Megacolon is a condition in which the rectum and pelvic colon, and sometimes the whole of the large intestine, are dilated and hypertrophied although no organic obstruction is present. The name Hirschsprung's disease, which is often used to describe megacolon in children, should be discarded, as at least four papers on the subject were published before 1888, when Hirschsprung's appeared, and no clear dividing line can be drawn between the megacolon of children and that of adults.

Megacolon must be distinguished from an abnormally long colon, so-called dolichocolon. The pelvic colon varies greatly in length but, although a very long pelvic colon may predispose to volvulus, there is no reason to believe that it predisposes to megacolon.

Megacolon in children is rare; I have seen only 11 cases compared with 38 in adults. In children it occurs almost exclusively in boys (10 out of 11 of my cases), whereas in adults the incidence is about equal in the two sexes (20 males and 18 females in my series). It is probable, therefore, that the majority of cases observed in adults do not date from childhood.

*Pathogenesis: Achalasia of the Sphincter ani:* I believe that the primary factor in the pathogenesis of all cases of megacolon is achalasia ( $\alpha$ , not;  $\chi\acute{\alpha}\lambda\alpha\sigma\iota\varsigma$ , relaxation) of the sphincter ani, *i.e.*, absence of the relaxation of the sphincter which should occur when the rectum contracts during defaecation. This is sufficient to prevent the easy evacuation of faeces, which are consequently retained.

The pelvic colon and rectum attempt to overcome the resistance offered by the closed anal sphincter by increased peristalsis, with the result that their walls gradually become hypertrophied. The thick walls of the fixed rectum give way less

readily than the comparatively thin walls of the freely movable pelvic colon, so that the rectum does not show the same degree of dilatation and in many cases it is only slightly enlarged. The distention of the pelvic colon results in an increase in its length as well as in its diameter. As it contains a great excess of gas, the dilated and elongated loop rises during the day when the individual is in the erect position, and eventually its upper extremity generally reaches the left dome of the diaphragm. The extreme degree of hypertrophy and dilatation does not as a rule extend beyond the pelvic colon, though a lesser degree is often present in parts or in all of the rest of the colon.

The pelvic colon, rectum, and internal sphincter of the anus have, like the rest of the alimentary tract, a double nerve supply, sympathetic from the 2d, 3d, and 4th lumbar ganglia, and parasympathetic from the 2d, 3d, and 4th sacral nerve roots. The latter have a cell station in the ganglia of Auerbach's (myenteric) plexus. Stimulation of the sympathetic nerves causes relaxation of the pelvic colon and rectum and spasm of the sphincter ani, and stimulation of the parasympathetic nerves causes contraction of the pelvic colon and rectum and relaxation of the sphincter. The achalasia of the anal sphincter which results in megacolon is the result of parasympathetic paralysis caused by inflammation, atrophy, or fibrosis of Auerbach's plexus (Cameron; Robertson and Kernohan; Etzel), corresponding with the similar changes always found in the oesophagus in achalasia of the cardia (so-called cardio-spasm) (Hurst and Rake, 1930; Hurst, 1943).

*Secondary Obstruction at Pelvi-Rectal Flexure:* If at the onset of the disease the fold of mucous membrane at the pelvi-rectal flexure is unusually prominent, the dilatation of the pelvic colon immediately proximal to it may exaggerate the kink. Although the primary condition is still the anal achalasia, the secondary obstruction caused by the kink at the pelvi-rectal flexure prevents the entry of gas and faeces

into the rectum so that it does not join in the progressive dilatation of the pelvic colon. The varying degree in which this secondary obstruction occurs accounts for the fact that in some cases the rectum either is not appreciably dilated or is only slightly dilated compared with the pelvic colon. In spite of this, it always appears much enlarged when an opaque enema is given. This shows that it must have been greatly distended at first, but that, when the pelvi-rectal kink developed and gas and faeces ceased to accumulate in the rectum, it contracted without, however, losing the abnormal distensibility caused by the earlier distention.

In the majority of cases a sigmoidoscope can be passed its full length of 12 inches blindly without meeting any resistance, whereas in normal persons it is rarely possible to pass it beyond the pelvi-rectal flexure without having to withdraw the obturator and guide the instrument by direct vision. Endoscopy shows the end of the instrument in the centre of an enormous cavity. On withdrawing it, no dividing line can be recognized between the pelvic colon and rectum, the dilatation of which extends to the entrance of the anal canal.

*Symptoms:* In children with megacolon there is almost always a history of constipation dating from birth or from the first few months of life. At an early stage the bowels cease to act spontaneously, and drugs gradually lose their effect until an evacuation can be produced only by means of enemas. Sometimes the bowels are opened daily, but the quantity passed is never sufficient, so that large accumulations of faeces collect in the distended colon. The stools are generally soft, but in less severe cases scybala may be passed.

Soon after the onset of constipation the abdomen, which at birth is normal in appearance, begins to increase in size owing to distention of the pelvic colon with gas and faeces, the size varying from time to time according to the extent to which the bowels are opened. Enormously dilated segments of colon can often be recognized

through the thin and stretched abdominal wall; they are dull on percussion, and palpation shows that they are filled with soft faeces. Digital examination of the rectum is painless; the anal canal offers no more than the normal resistance and there is no hypertrophy of the sphincter. The rectum is generally much dilated and filled with soft faeces or less often with a large solid faecal ball. If secondary obstruction has developed at the pelvi-rectal flexure, the rectum is empty and faeces can be felt in the pelvic colon through its anterior wall.

With proper treatment the child is able to lead a normal life and is free from symptoms of toxæmia, but if he is neglected, enormous accumulations of faeces collect. Formerly, before the true nature of the condition was recognised, the bowels sometimes ceased to act at all and death occurred from chronic faecal obstruction.

The gas in the dilated pelvic colon is under considerable pressure. In small children it pushes the diaphragm up and the abdominal wall forwards, but in older children and in adults the appearance of the abdomen is generally less abnormal and is sometimes quite normal, as the diaphragm, which does not receive any support from above owing to the negative intrathoracic pressure, gives way before the abdominal muscles. The increase in the capacity of the upper part of the abdominal cavity produced in this way provides sufficient space for the greater part of the dilated colon.

Megacolon is compatible with perfect health. The majority of my adult patients came for advice on account of nothing more than constipation, which was generally no more severe than that occurring in many persons without any organic disease, and the abdomen was not obviously distended. In 5 patients the condition was accidentally discovered in the course of a routine investigation on account of abdominal symptoms caused by some other condition.

Toxic symptoms do not develop unless aperients have been taken in excess. Megacolon does not appear to endanger

life; 16 of my 36 private patients were over fifty and an additional 9 were over forty when I first saw them, although the condition had presumably been present for many years, if not from infancy.

All the children with megacolon I have seen since 1920 are developing normally and appear to be none the worse either physically or mentally for having had a dilated colon. Two of them, who were first seen in 1923 with a pelvic colon extending to the diaphragm, are now flying officers and their bowels work regularly without artificial aid.

In a small proportion of cases the patient complains of sudden attacks of very severe pain with abdominal distention caused by partial volvulus of a loop of the long and dilated pelvic colon. Mild attacks in which the pain is not very severe and the distention is slight occur much more often. Either type of attack may last for anything between a few hours and a few days and almost always subsides spontaneously. In 2 of my patients, both men of over sixty, a carcinoma developed in the dilated colon.

Although the diaphragm is almost completely out of action and the capacity of the chest is much reduced, there is no complaint of dyspnoea. Several of my patients were able to take strenuous exercise and the majority were physically well developed. In most cases the left dome of the diaphragm alone is involved; it may reach the level of the third or fourth rib and is always higher than the right dome. In 2 cases the heart was pushed over to the right. In 5 the pelvic colon was so long and dilated that its upper extremity crossed the middle line after reaching the diaphragm on the left side and passed in front of the liver so as to intervene between its upper surface and the right dome of the diaphragm. Its gas-containing cavity was seen with the x-rays to be in contact with the diaphragm on both sides.

*Radiological Examination:* (a) *Preliminary Examination:* Every x-ray examination should begin with an inspection of the patient in the erect position before he has had

an opaque meal or enema. The possibility of a megacolon is at once suggested by the discovery of "eventration of the diaphragm." The abnormally high position of the left dome of the diaphragm presents such a striking appearance that it can hardly be missed. It is generally possible in megacolon to recognise the outline of the enormously dilated air-containing loop of pelvic colon and to distinguish it from the gas bubble in the fundus of the stomach, which is always limited below by the horizontal upper border of the shadow of the gastric contents. When a gas-containing cavity is seen under the right dome of the diaphragm as well as the left, the diagnosis of megacolon is certain.

As the diaphragm in megacolon is displaced into what is normally part of the thoracic cavity, the condition present might with justice be called eventration of the diaphragm. This name, however, is generally reserved for a condition in which the high position of the diaphragm is the result of a congenital defect in its musculature rather than of an acquired exaggeration in the upward thrust from below. In congenital eventration the left half of the diaphragm is always involved alone; it is represented by a fibrous membrane containing only a few scattered muscle fibres, so that it is incapable of contracting. In deep respiration it moves passively up in inspiration and down in expiration, i.e., in the reverse direction to the normal right half of the diaphragm. When the high position of the diaphragm is secondary to megacolon, there is a small movement in the normal direction.

The eventration of the diaphragm which results from maldevelopment of its musculature is very rare compared with that due to megacolon; I have seen only 2 cases of the former, compared with 49 of the latter. If the term eventration of the diaphragm is to be retained at all, it would be more logical to include all cases in which the diaphragm is abnormally high, instead of using it only for those in which there exists a congenital defect in development. Cases would then be classified as follows: (i) primary, due to maldevelopment of one-half of the diaphragm, always left-sided; (ii) secondary to atrophy following interference with the nerve-supply; this may occur on either side and is a result of (a) disease, most commonly secondary carcinoma, but occasionally primary carcinoma of the lung, tuberculosis, Hodgkin's disease, and aneurysm, or (b) therapeutic division or avulsion of the nerve; (iii) secondary to (a) *aërogastric bloqué* (Hurst, 1938) or (b) megacolon

(b) *Opaque Meal:* An opaque meal does not help greatly in the diagnosis of mega-

colon, but it is a valuable corrective for the false conclusions which might otherwise be drawn from an examination after an opaque enema. It shows how much of the colon is undilated and also the degree of stasis present and where the stasis occurs. The small intestine is always normal. In most cases the large intestine as far as the end of the iliac colon at the brim of the true pelvis is normal in size and there is little or no stasis in it, although an opaque enema may have led to the conclusion that the splenic flexure is hugely dilated. The explanation of this is given below. When the barium passes beyond the iliac colon, it is lost in the cavity of the pelvic colon, small spots of opaque material being scattered over the whole of the enormous area it occupies. Stasis of varying degrees is always present in the pelvic colon. In well compensated cases, in which the bowels are opened daily, there is no delay in the evacuation of the greater part of the opaque meal, but a small quantity generally remains scattered through the pelvic colon for many days or even weeks.

(c) *Opaque Enema*: X-ray examination after an opaque enema is an essential part of the investigation of every case of megacolon. It is necessary to watch the fluid being run in, as it is otherwise impossible to interpret a radiograph owing to the large amount of overlapping of different segments of the bowel caused by the enormous dilatation of the pelvic colon. What is generally mistaken for a dilated splenic flexure is in almost every case the pelvic colon, which lies in front of and obscures a splenic flexure of more or less normal size. The fluid is seen to run straight upwards through a greatly dilated rectum and pelvic colon to the left dome of the diaphragm. Even if the rectum is not found to be dilated on digital examination, it is always distensible and no resistance to the passage of the enema into the pelvic colon is encountered; it is in fact often impossible to recognise where the rectum ends and the pelvic colon begins. After reaching the diaphragm, the fluid passes downwards again, but often not until it has made a

more or less complicated loop, which may reach the right dome of the diaphragm in front of and above the liver. It finally reaches the left brim of the pelvis, where it passes upwards again along the iliac and descending colon to the splenic flexure. The splenic flexure, together with most of the transverse colon and all of the descending colon and iliac colon, is entirely obscured by the pelvic colon, which lies in front of it. The fluid passes without difficulty into the caecum. Very large quantities of fluid are required to render the whole colon visible, the pelvic colon alone holding 6 to 12 pints. The colon in children may require as much as 4 to 6 pints, and in babies 1 1/2 to 2 pints.

The size of the colon as shown in a radiograph taken after an opaque enema is no guide to its actual size nor its tonicity, but is an indication of its distensibility. It does not correspond with the condition present immediately before the enema is given, because the walls of the colon relax in order to allow more and more fluid to enter until the maximal size which has been present at any recent time is attained. This explains why the pelvic colon in a case of megacolon, in which more or less complete relief has followed treatment, often appears to be enormously enlarged when examined after an opaque enema, though any abdominal distention present previously may have disappeared and an opaque meal and sigmoidoscopic examination may show no abnormality.

*Treatment*: Before discussing the results of treatment, whether non-operative or operative, it is necessary to point out that improvement in function should be the main criterion of success. A colon which has once been over-distended for any length of time remains permanently over-distensible, even if the over-distention has been completely overcome and the lumen is perfectly normal. It is best not to give an opaque enema after treatment, however successful, unless the patient is previously warned that it may show no change, as the disappointment may lead to a relapse which is purely psychological in origin.

The main object in the treatment of megacolon is to lessen the resistance offered by the closed anal sphincter to the passage of faeces and gas. Rapid stretching of the sphincter is not as a rule effective, as it *quickly contracts again to its original state*. For a permanent result, the postural tone of the muscle fibres of the sphincter must be permanently reduced. This can best be attained by the use of a conical vulcanite bougie which is passed every morning just after the first attempt to open the bowels has been made. The bougie is perforated along its axis in order to allow gas to escape from the rectum. It is pushed slowly in as far as it will go without causing discomfort and kept in position for half an hour. Intelligent patients quickly learn to pass it for themselves, and the mother or nurse can pass it for children. A second attempt to defaecate is made immediately afterwards. At the end of about a week the bougie need be kept in position for only a quarter of an hour; at the end of a month it is passed on alternate days, then once a week, and finally it is used only in the event of a return of symptoms.

When a child with megacolon comes under treatment, there is generally a large accumulation of faeces in the pelvic colon and, in about 50 per cent of cases, in the rectum also. The latter are easier to treat, because, when the rectum is empty and a secondary kink has developed at the pelvic-rectal flexure, treatment of the anal achalasia does not help until the dilatation of the pelvic colon has been overcome by keeping it nearly empty for some time; its contents can then pass without difficulty into the rectum. In adults such an accumulation is less often found, though in neglected cases and in all of the comparatively small number which have come to necropsy huge quantities of faeces are present. In both children and adults there is always a very large accumulation of gas in the dilated segment of bowel. Before any permanent improvement can be attained, the faeces and gas must be evacuated as completely as possible. Aperients are quite useless, and enemas are not always effective, as a good

deal of the water injected is often retained. In neglected cases in children the best results are obtained by evacuation under a general anaesthetic, partly by lavage with simultaneous abdominal kneading and partly by the finger, faeces being removed from the rectum after being pushed into it by pressure on the abdomen. The faeces are generally soft, but sometimes a secondary cause of obstruction is present in the form of a solid ball of faeces, which acts as a ball-valve in the rectum, and must be broken up and removed bit by bit before the colon can be emptied.

After the colon has been evacuated and the resistance offered by the anal sphincter reduced, the patient is generally able to get his bowels satisfactorily opened every day. No aperient should be given, but paraffin may be needed to prevent the faeces from becoming hard. In many cases no further treatment is required. Sometimes, however, especially if the dilatation has been excessive, there is still a tendency for faeces to accumulate in the pelvic colon in spite of the bowels being opened daily. It is then necessary to give an occasional enema. This need not be done more than once a week, and sometimes once a month is sufficient. In some cases the best results are obtained with a very large enema, as much as 8 or 10 pints being run in under low pressure; in other cases most of the water is retained when large quantities are given, and quite satisfactory results are obtained with a single pint.

When attacks of pain and distention, presumably due to partial volvulus, recur in spite of treatment, immediate relief can be often obtained by the passage of a flatus tube. If this fails and the pain is severe, morphine and atropine should be injected.

*Surgery:* Such operations as colostomy, ileo-sigmoidostomy, and colectomy, which were formerly practised in these cases, had a very high mortality and rarely led to any appreciable improvement, as the primary seat of obstruction, the anal canal, was left untouched. Occasionally, however, it may become necessary to remove a single loop of the pelvic colon which has formed a

chronic volvulus and gives rise to frequent attacks of acute pain from partial obstruction.

Recently various operations on the sympathetic nervous system—especially division of the presacral nerve and the 1st to the 4th lumbar roots of both sides and removal of the inferior mesenteric plexus—have been performed with the object of reducing the tone of the anal sphincter. This proved remarkably successful in boys, though quite useless for the megacolon of adults; but equally good results could be very much more simply attained by local treatment. The operation has the further disadvantage of being invariably followed in males by permanent loss of ejaculatory power and consequent sterility. In 1935 Stabins, Morton, and Merle Scott noticed that a number of children with megacolon, to whom a spinal anaesthetic had been given for diagnostic purposes before resorting to sympathectomy, were cured, although no operation was performed. It seems likely that the improvement following sympathectomy was really the result of the spinal anaesthetic

used for the operation or for diagnostic purposes. In any case there is now no excuse for performing sympathectomy, but a spinal anaesthetic should be used in place of general anaesthesia when difficulty is experienced in emptying the rectum and pelvic colon by enemas alone.

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#### REFERENCES

- CAMERON, J. A. M.: On Aetiology of Hirschsprung's Disease. *Arch. Dis. Childhood* 3: 210-211, August 1928.
- ETZEL, E.: Megaoesophagus and Its Neuropathology: Clinical and Anatomic-Pathological Research. *Guy's Hosp. Rep.* 87: 158-174, April 1937.
- DELANO, P. J., RONAYNE, F. J., AND BOLAND, T. B.: Rectal Dyschezia: A Misnomer for Megarectum. *Radiology* 37: 730-732, December 1941.
- HURST, A. F.: Anal Achalasia and Megacolon (Hirschsprung's Disease; Idiopathic Dilatation of Colon). *Guy's Hosp. Rep.* 84: 317-350, July 1934.
- HURST, A. F.: *J. Laryng. & Otol.* 1943.
- HURST, A. F., AND RAKE, G. W.: Achalasia of Cardia (So-Called Cardiospasm). *Quart. J. Med.* 23: 491-508, July 1930.
- LEHMANN, W.: Die Ätiologie der sog. spastischen Erkrankungen des Magen-Darmkanals (Pylorospasmus, Kardiospasmus, Hirschsprungsche Krankheit). *Beitr. z. klin. Chir.* 151: 395-470, 1931.
- ROBERTSON, H. E., AND KERNOHAN, J. W.: Myenteric Plexus in Congenital Megacolon. *Proc. Staff Meet., Mayo Clin.* 13: 123-125, Feb. 23, 1938.





# Roentgen Study of the Fetus in Utero:

## Some Practical Considerations<sup>1</sup>

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THE ROENTGEN study of the fetus *in utero* may furnish considerable information which is of practical bearing in the conduct of labor. In our experience with over 2,500 roentgen studies in pregnancy where abnormality was suspected, we have naturally developed a point of view and approach to the study of the fetus which is somewhat different from that of the obstetrician at the bedside or of the pathologist. Such a point of view assumes some importance in view of the fact that the roentgenologist is being called upon for his opinion in such matters.

The roentgen findings that may be obtained regarding the fetus could be grouped as follows:

1. Size and age.
2. Fetal death.
3. Normal and abnormal fetal positions.
4. Extension or deflection of the fetal head.
5. Fetal head engagement.
6. Congenital and acquired diseases.

**Fetal Size and Age:** When there are sufficient lime deposits in the bones so that the fetus may be visualized *in utero*, it is from twelve to fourteen weeks old. From that time until close to term its age can be estimated by simple inspection of the fetal roentgenogram. We use a lateral view because we depend upon it for location of the placenta and because on it the fetal parts are usually more clearly outlined than on the anteroposterior film, where the maternal spine and intestinal gas shadows may interfere. The size of the image may be influenced by the film-target distance, the size of the mother, and the closeness

of the fetus to the film. We try to place the mother for the lateral roentgen view with the fetus near the film. This is more often with the left side down, since left



Fig. 1. Overlapping of skull sutures, Spalding's sign of fetal death.

occipito-anterior is the most common position. Sample films of the fetus *in utero* of different ages should be on hand for comparison.

The fetal size and age may also be inferred from the size of the head, the perimeter or the occipito-frontal diameter in particular. Such methods have been developed, especially by Ball, Hodges, Thoms, and Clifford. It has been our practice to find the skull perimeter by first computing the theoretical average diameter after McNeill. The occipito-frontal diameter results parallel those obtained from the perimeter.

<sup>1</sup> Presented before the Radiological Society of North America, at the Twenty-eighth Annual Meeting, Chicago, Ill., Nov. 30-Dec. 4, 1942.

Occipito- Frontal Skull Diameter	Skull Perimeter with Scalp Thickness	Fetal Age	Average Fetal Weight
8.0- 8.5 cm.	20 cm.	25 wk.	1 lb., 1 oz.
9.0- 9.5 cm.	25 cm.	30 wk.	3 lb.
10.5-11.0 cm.	30 cm.	36 wk.	5 lb.
11.0-11.5 cm.	33 cm.	40 wk.	6-7 lb.
11.5-12.0 cm.	34 cm.	40 wk.	7-8 lb.

Like other workers in the field, we have found that estimation of weight when the



Fig. 2. Abdominal pregnancy: fetus lying high and transversely.

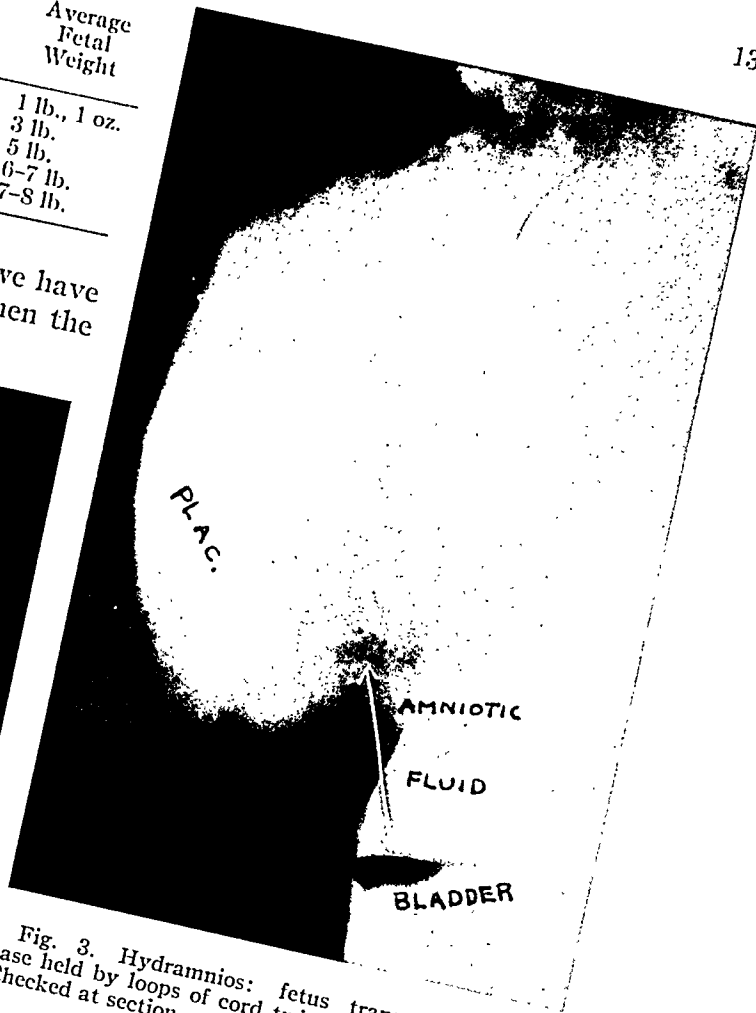


Fig. 3. Hydramnios: fetus transverse. Similar case held by loops of cord twisted firmly about fetus. Checked at section.

fetus is at term, or especially if it is over 7 pounds, is not always dependable. We therefore have been attempting to estimate the weight by a consideration of a number of factors and their correlation.

1. The general size of the fetus as it appears on the film, this being fairly reliable up to term.
2. The size of the bones.
3. The skull perimeter or diameter.
4. The amount of subcutaneous fat evidenced in the fetus. This can be seen best over the breech and is visualized as a black line of de-

marcation. When the fetus is past due, the fat is usually more abundant. In some cases the fetus appears to be long and thin and shows only a thin layer of subcutaneous fat.

5. The appearance of bony centers of ossification.

Despite the fact that we use these various devices in estimating the fetal weight, we find that we must exercise considerable caution in expressing our results. We would recommend that near term the fetal weight be given as follows, preferably omitting actual numbers:

- Small.....5 1/2 to 6 1/2 lb.  
Medium.....6 1/2 to 7 1/2 lb.  
Large.....Over 8 lb  
Very large.....Over 9 lb

*Fetal Death:* The roentgen signs of fetal death have been repeatedly and adequately described. The Spalding sign of overlapping of the skull sutures before labor is the earliest evidence of which we know (Fig. 1). In our experience it was first observed four days after the fetal

extending downward from the fundus. His results were obtained by floating the placenta and the amniotic sac, after its extrusion, in a large container of water. Independently, we have arrived at the same conclusion regarding the location of the placenta, as a result of roentgeno-



Fig. 4. Large fibroid located posteriorly in lower uterine segment displacing fetal skull. Section was necessary.

heart stopped. Later, the spine may become abnormally curved and the fetus may assume positions which are obviously abnormal. Still later the fetus may disintegrate or shrink into a lithopedion. It will usually be expelled, however, before this happens.

*Normal and Abnormal Positions:* The normal positions are of interest, particularly at term. They are well recognized and need no review in this report. As has been clearly and ably demonstrated by Torpin, the uterine cavity is wider than it is deep at term. He showed that in over 90 per cent of the cases the placenta is located anteriorly or posteriorly,

graphic study. Combining the above observations, we find that the general disposition of the fetus in the uterus is more or less such that it lies with its back to the right or to the left of the mother. Since the placenta is in front or in back, the fetus, therefore, half faces it from its left or from its right.

Abnormal positions of the fetus frequently give rise to serious disturbances and are therefore of utmost importance. They may be due to abnormality of the soft parts, such as placenta praevia, the presence of fibroids, abdominal pregnancy (Fig. 2), or hydramnios (Fig. 3). If a fibroid is located posteriorly and below

(Fig. 4), normal delivery is unlikely. If the fibroid is situated anteriorly and below, it frequently rises above the symphysis, permitting delivery from below. Congenital developmental change or death of the fetus may also produce abnormal position in the uterus.

pendulous abdomen; (9) abdominal pregnancy.

Hyperextension or abnormal flexion of the head during labor may be due to some of the above mentioned causes but is most commonly the result of cephalopelvic disproportion or occiput posterior.



Fig. 5. Hyperextension of head. Umbilical cord found around fetal neck as the cause.

*Extension or Deflection:* A careful consideration of the degree of flexion or deflection of the fetal head may be of practical value, furnishing important information.

Before labor, the head may be normally in military position or slightly flexed or slightly extended.

Hyperextension of the head before labor may be due to any of the following causes: (1) umbilical cord around the fetal neck (Fig. 5); (2) hydramnios; (3) placenta praevia; (4) pelvic masses, such as fibroids or ovarian tumors; (5) distention of the bladder or rectum; (6) twins; (7) large tumor about the neck of the fetus, as thyroid tumor, branchial cyst, or hygroma; (8) occiput anterior and

By elimination, we have been able to diagnose looping of the cord about the neck, with hyperextension. For one such case we are indebted to Dr. U. J. Salmon. It is possible to make this diagnosis on roentgen study because the appearance of hydramnios, placenta praevia, abdominal pregnancy, and pelvic masses is fairly typical; twins are easily excluded; the bladder is emptied before the film studies are made; fecal masses in the colon may be recognized; a pendulous abdomen of the mother is obvious; and tumors of the fetal neck are so rare that for practical purposes they may be disregarded. There are some cases of hyperextension of the fetal head, however, in which the cause is unknown.

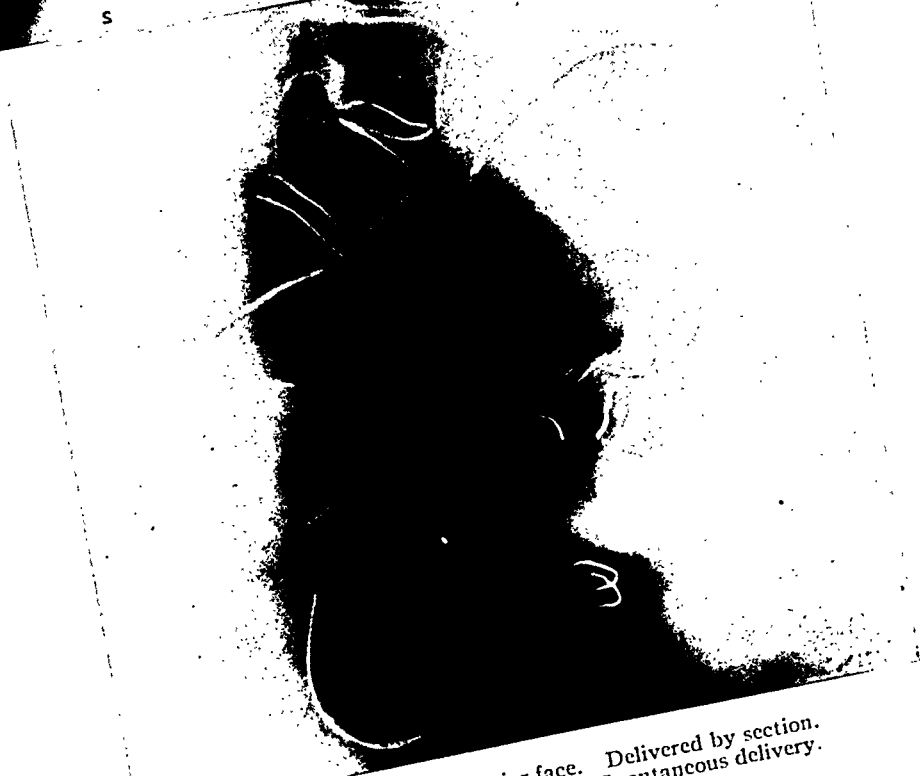


Fig. 6 (above). Posterior face. Delivered by section.  
 Fig. 7 (below). Anterior face. Spontaneous delivery.

In brow or face presentation, the occurrence of active labor often indicates a marked cephalopelvic disproportion. With a posterior face (Fig. 6), vaginal delivery is rarely possible. With an anterior face, all other conditions being favorable, delivery from below is possible (Fig. 7).

With occiput posterior, the head often maintains a somewhat extended position as it descends into the pelvis until the frontal bones are forced against the symphysis of the mother. Some flexion then develops. The extension is possible because the curve of the sacrum makes room for the occiput (Fig. 8).

*Fetal Head Engagement:* In this brief paper we cannot go too far into the subject of head engagement. It has been our experience that few cases are sent for roentgen study when the head is well engaged. Once the head has descended well into the pelvis, the likelihood of dystocia is limited to a few possibilities. The conditions mentioned above as producing deflection of the head naturally interfere with fetal head engagement. By far the most common cause, in our experience, has been cephalopelvic disproportion. In a few of our cases, there was no evidence of a disproportion but the head would not engage because of the fact that an arm presented before it.

*Congenital and Acquired Diseases:* Fetal monstrosities are amazingly varied. The importance of diagnosing these before delivery is evident. Roentgen study is a most reliable aid in this connection. It has been advocated that in every case requiring cesarean section x-ray studies should be made prior to operation to avoid delivery of a monster. One of the most common fetal abnormalities recognized *in utero* is acrania or anencephaly, which is almost always associated with marked hydramnios, the roentgen appearance of which we have described. It consists in geometric soft smooth shadows surrounding the fetus. The fetus also shows a thick layer of subcutaneous fat, evidenced by the broad black line of demarcation.

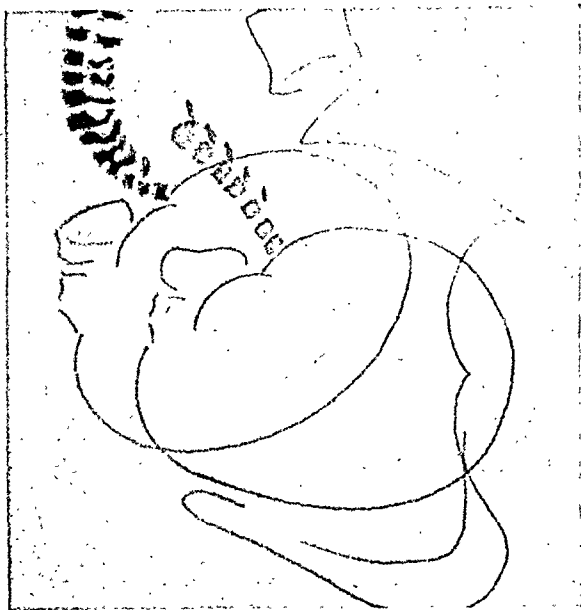


Fig. 8. Occiput posterior. This may normally show poor flexion or even some extension. When the head descends, it flexes as the frontal bones meet the maternal symphysis.

Elephantiasis congenita should be recognizable by the demonstration of extensive fat deposits about the fetus. The roentgen line of demarcation produced by subcutaneous fat is considerably widened.

In symmelus or mermaid there is fusion of the bones of the lower extremities to a greater or lesser degree.

Osteogenesis imperfecta shows extensive deformity of the bones, usually with multiple fractures.

Hydrocephalus is not uncommon. The enormous size of the head is typical.

Premature closure of sutures or unusual thickening of the skull has interfered with molding and caused dystocia in an otherwise favorable case.

Among other fetal conditions that may be recognized are extensive spina bifida, hemivertebrae, supernumerary digits, syphilis, rickets, and fractures.

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#### BIBLIOGRAPHY

- BALL, R. P.: Pelviccephalography. *Am. J. Obst. & Gynec.* 32: 249-257, August 1936.  
CLIFFORD, S. H.: Determination of the Weight and Age of the Fetus in Utero by the Aid of Stereoröntgenometry. *Surg., Gynec. & Obst.* 58: 959-961, June 1934.

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- HODGES, PAUL C.: Roentgen Pelvimetry and Fetometry. *Am. J. Roentgenol.* 37: 644-662, May 1937.
- MCNEILL, C.: Roentgen Technique, Springfield, Ill., Charles C Thomas, 1939, pp. 262-264.
- SNOW, W.: Clinical Roentgenology of Pregnancy. Springfield, Ill., Charles C Thomas, 1942.
- SNOW, W., AND ROSENTOHN, M.: Roentgenologic Visualization of the Soft Tissues in Pregnancy. *Am. J. Roentgenol.* 42: 709-717, November 1939.

SPALDING, A. B.: Pathognomonic Sign of Intra-Uterine Death. *Surg., Gynec. & Obst.* 34: 754-757, June 1922.

THOMS, H.: Fetal Cephalometry in Utero; Method for Estimating Occipitofrontal Diameter, and Statistical Study of Cephalic Measurements in 149 Unmolded Heads. *J. A. M. A.* 95: 21-24, July 5, 1930.

TORPIN, R.: Description of a New Method of Studying Placentation by Amniotic Sac Distention. *Am. J. Obst. & Gynec.* 35: 683-685, April 1938.



# Spondylolisthesis: A General Consideration with Emphasis on Radiologic Aspects<sup>1</sup>

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MANY EXCELLENT descriptive and analytical papers have appeared concerning spondylolisthesis since Killian first described it in 1853 and Lovett reported the first traumatic case in 1897. The purpose of this paper is to consider the condition chiefly from the standpoint of diagnosis. If some of the statements are repetitive, the desire for emphasis is responsible.

Spondylolisthesis signifies a displacement of the vertebral column, usually anteriorly, occasionally posteriorly, as the result of a dissolution of continuity or defect of the pars interarticularis of the neural arch of a vertebra. Prespondylolisthesis is the term used to indicate the presence of such a defect, in the sense of a zone of inadequate ossification. This may be unilateral or bilateral and, except in purely traumatic cases, is always the precursor of spondylolisthesis. The essential difference between the two conditions is that, while both present a defect in the posterior neural arch, in spondylolisthesis there is, in addition, *displacement* of the involved vertebra. The term prespondylolisthesis should be limited to those cases which present a demonstrable unilateral or a bilateral defect *without slipping*. It should not be employed to label an obtuse lumbosacral angle or almost horizontal sacrum. Because the shearing forces are unusually great in the region of the 5th lumbar vertebra and 1st sacral segment, such a condition may be a potential spondylolisthesis, but so long as it shows no other change it is neither a spondylolisthesis nor a prespondylolisthesis; it is merely a mechanically bad low back. The designation prespondylolisthesis for this type of case, though sometimes

found in the literature, is obviously a misnomer.

*Incidence:* Various authors have placed the incidence of spondylolisthesis at from 5 to 6 per cent. Fifty per cent of the cases are seen in the third and fourth decades; 76 per cent are in males; 80 per cent occur between the 5th lumbar vertebra and 1st sacral segment, and 50 per cent show Grade I (Meyerding) displacement.

The series of cases to be presented here represents an incidence of over 10 per cent. One hundred and forty-two routine lower spine examinations disclosed 15 cases of prespondylolisthesis or spondylolisthesis.<sup>2</sup> In considering this figure, one must remember that no females were examined; that the average age was twenty-eight years, and that the subjects were all soldiers exposed to many types of hazard. In view of the rather high incidence, and in spite of the fact that this may have been influenced by the age group and particular occupation of the subjects examined, we believe this condition to be much more prevalent than is ordinarily anticipated. In emphasis of this point, we may mention the fact that 4 cases were selected from routine abdominal film studies for urological and gastrointestinal study, not undertaken for examination of the lower back. We believe that diligent search for the defect will reveal it in many unsuspected cases. This contention is borne out by the high incidence in the present series of cases, which were, for the most part, the object of purposeful scrutiny of the lumbosacral area.

*Mechanics Involved:* That the lumbosacral area presents a large number of confusing anatomical variations is indis-

<sup>2</sup> Since this article was submitted, 20 additional cases have been seen, making a total of 35, of which 3 were unilateral prespondylolisthesis, 17 bilateral prespondylolisthesis, and 15 spondylolisthesis.

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putable. We shall concern ourselves only with the articular processes of the 5th lumbar vertebra and the 1st sacral segment. As is well known, the plane of articulation of the inferior articular processes of the 5th lumbar vertebra and the superior articular processes of the 1st sacral segment varies considerably. This plane may lie in a sagittal, a coronal, or an oblique

oretically at least, the weak type of lumbosacral area, since under these conditions the buttress effect would be minimal. The superior articular processes of the 1st sacral segment are in reality mighty props that restrain the tendency of the spine to slip forward. A study of these processes will show them to be solid, thick, and firm in most cases, as they very aptly should be.

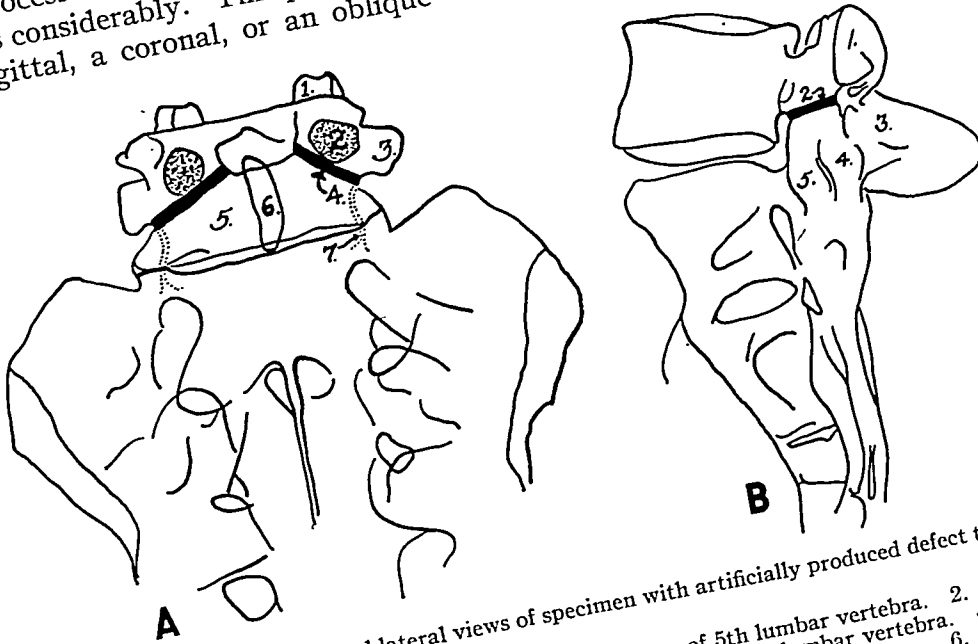


Fig. 1. Anteroposterior and lateral views of specimen with artificially produced defect through pars interarticularis.

A. Anteroposterior view: 1. Superior articular process of 5th lumbar vertebra. 2. Pedicle of 5th lumbar vertebra seen on end. 3. Transverse process of 5th lumbar vertebra. 4. Artificially produced defect through isthmus. 5. Lamina of 5th lumbar vertebra. 6. Spinous process of 5th lumbar vertebra. 7. Articular process of 5th lumbar vertebra and 1st sacral segment.

B. Lateral view: 1. Superior articular process of 5th lumbar vertebra. 2. Artificially produced defect through isthmus. 3. Spinous process of 5th lumbar vertebra. 4. Inferior articular process of 5th lumbar vertebra. 5. Superior articular process of 1st sacral segment.

direction, or a combination of any of these. Thus, the plane on one side may be sagittal and on the other side coronal or oblique. A wide variety of arrangements are possible and are commonly seen. From the standpoint of stability based on shearing forces, the ideal plane of articulation should be coronal-oblique bilaterally. This would permit rotating motion in all directions and at the same time the superior articular processes of the 1st sacral segment would act as an ample buttress against the forward and downward drive of the inferior articular process of the 5th lumbar vertebra. A bilaterally sagittal plane of articulation should produce, the-

The lumbosacral angle is another important factor in a consideration of stability of the lower spine. The normal angle is approximately 42 to 45 degrees; the more obtuse this angle the more horizontal the sacrum and the less supportive effect afforded by the superior articular surface of the sacrum with reference to the spine above. In other words, the greater the angle the less stability at the lumbosacral area.

Additional support is rendered the lower back in this region by the anterior longitudinal ligaments, which, however, are not particularly effective, being comparatively thin structures. The iliolumbar, the sacro-

iliac, and the interspinous ligaments act as strong supporting agents and in the presence of a defect in the posterior neural arch these structures are called upon to exert their greatest effort to keep the lower lumbar spine in place with respect to the first sacral segment. At best, however, the lumbosacral joint must be considered an unstable mechanism. It is a junction

*Pathology and Anatomy:* The 5th lumbar vertebra is too well known a structure to require a detailed anatomical description. One may recall, however, that the posterior neural arch is really an osseous ring bounded anteriorly by the posterior surface of the body of the vertebra, laterally by the pedicles, posterolaterally by the superior and inferior processes, and

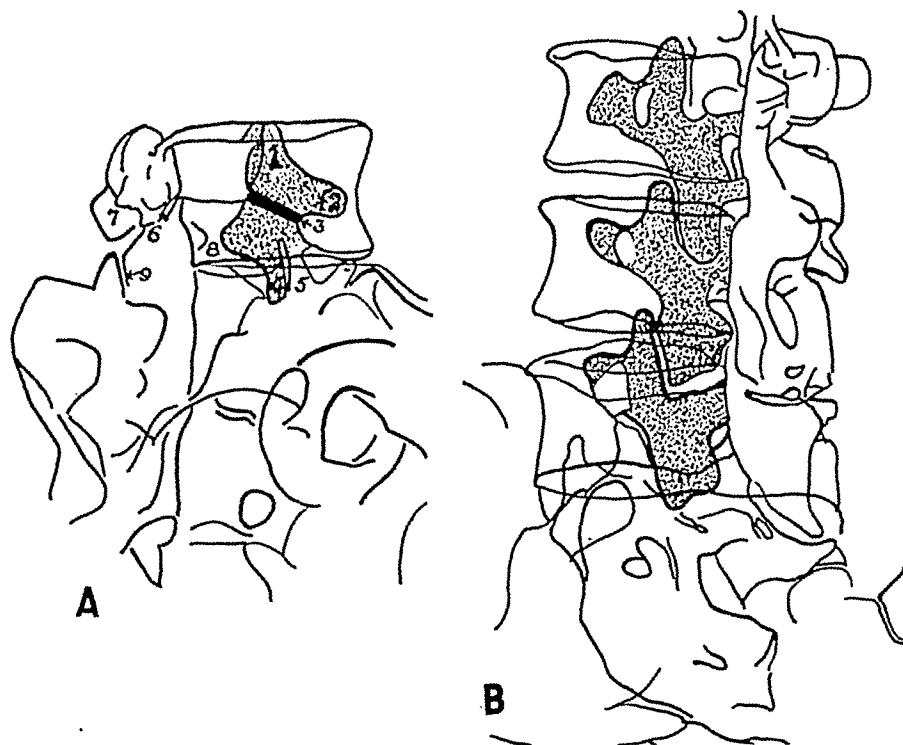


Fig. 2. Oblique views of specimen with artificially produced defect through pars interarticularis.

A. Dotted areas represent typical "bow-tie." Dark heavy line represents site of artificially produced defect. 1. Superior articular process of 5th lumbar vertebra. 2. Tip of transverse process superimposed on superior articular process. 3. Defect through pars interarticularis. 4. Inferior articular process of 5th lumbar vertebra. 5. Superior articular process of 1st sacral segment. 6. Joint space between superior and inferior articular process of 5th lumbar vertebra and 1st sacral segment. 7. Spinous process of 5th lumbar vertebra. 8. Lamina of 5th lumbar vertebra. 9. Joint space between inferior articular process of 5th lumbar vertebra and superior articular process of 1st sacral segment, opposite side.

B. Dotted areas represent "bow-tie." Light areas within dotted areas represent tips of transverse processes seen on end.

of a mobile and immobile part. It represents an area of phylogenetic shortening consequent to change in posture from the horizontal to the erect. It is the site of a rotating type of action, which is often based on asymmetrically placed facets, and is always subject to tremendous shearing strain.

posteriorly by the laminae and spinous process. That portion of the posterior neural arch which lies between the superior and inferior articular processes and just behind and below the posterior portion of the pedicles is known as the pars interarticularis, isthmic zone, or isthmus. It is with this particular region that we are

TABLE I: FIFTEEN CASES OF SPONDYLOLISTHESIS AND PRESONDYLOLISTHESIS

Case	Age (years)	History of Injury	X-ray Findings	Neurological Symptoms		Subjective Symptoms		Objective Symptoms		Duration of Symptoms since 1936
1	28	None. Fit of violent coughing (5/3/43) and severe back pain	Spondylolisthesis, Grade	1st	None	Pain in lower back; no radiation	None	Loss of lumbar lordosis	2 years	
2	33	Auto accident 6/7/41	Spondylolisthesis, Grade		None	Knife-like pain in lower back, aggravated by bending; sciatica	Symmetrical atrophy, both legs		6 months	
3	19	None. Cold with cough Nov. 1942. Pain in right hip on coughing	Spondylolisthesis, Grade	1st	None	Pain so severe patient could not bear weight on right hip	Tenderness over 1st sacral segment. Loss of lumbar lordosis, spasm of lumbar muscles with limitation of motion		9 years	
4	27	Injured playing football, 1934	Prespondylolisthesis, bilateral		None	Pain in lower back, right buttock, right leg	Spine immobile. Decreased lumbar lordosis. Muscle spasm. Limitation of motion		2 1/2 years	
5	42	Fracture of 2nd lumbar vertebra, auto accident	Spondylolisthesis, Grade	1st	None	Pain in lower back, worse last 8 months	Moderate tenderness over 1st sacral area ?		18 months	
6	21	Thrown from horse, 1941	Fracture 2nd lumbar vertebra, auto accident		None	Low back pain; some radiation to rt. thigh	Increased flexion and extension, left hip		No history 3 months	
7	42	None	Prespondylolisthesis, unilateral right side		None	Arthritis, non-suppurative, left foot	No history 4 a little prominent. Moderate tenderness to right of lumbar 5. Discomfort and hyperextension and hyperflexion		None	
8	24	No history	Spondylolisthesis		None	No history	None		1 week. On working 3 months later, pain recurred	
9	24	Caught under truck 9/14/41; also fall down steps 2/24/43	Unilateral prespondylolisthesis		None	Low back pain; no radiation	Lumbar 4 a little prominent. Moderate tenderness to right of lumbar 5. Discomfort and hyperextension and hyperflexion		13 years	
10	22	None. Condition seen on colon films 1938; all on back in 1938; all most paralyzed both legs. No x-rays	Spondylolisthesis, Grade	1st	None	None	Slight kyphosis, lower lumbar			
11	28	Fell on back in 1938; all most paralyzed both legs. No x-rays	Reverse thesis		None	Pain in lower back radiating to right hip. Relief on rest in bed	Slight tenderness over left sacroiliac. Motion increases pain			
12	33	Pain in back after ride in jeep (5/10/43). Fractured 2nd lumbar, probably old. Football injury in 1930. No x-rays then	Reverse thesis		None	Low back pain, worse when standing or bending; radiation to left hip and thigh	None			
13	22	Defect noted in review of films taken elsewhere	Prespondylolisthesis, bilateral		None	Area of anesthesia over lower back and entire left leg, without organic basis	None			
14	35	Defect noted on genitourinary films	Prespondylolisthesis, bilateral		None	Lower reflexes markedly exaggerated	Lower backache			
15	27	Defect noted on gastrointestinal films	Prespondylolisthesis, bilateral		None		None		3 years	

concerned. Here is found the defect or dissolution of continuity of the posterior neural arch which occurs in prespondylolisthesis and spondylolisthesis. Instead of a solid core of bone being present, as occurs normally, there is a connecting zone of cartilage or cartilage plus a thin core of bone. The plane of this break is usually slightly oblique, with the middle portion directed slightly upward and the lateral portion slightly downward. The defect may, however, be transverse. We have never seen it occur in any other plane than the two above cited. This defect, or break, may be unilateral or bilateral. Naturally, bilaterality means much greater weakness at these points, since a unilateral defect leaves one sound pars interarticularis for support. When the defect is bilateral, the body of the vertebra must of necessity, if subjected to sufficient strain, lose its anchor to the pelvis. That portion of the neural arch anterior to the defect, namely the body of the vertebra, the pedicles, and the superior articular processes, is separated from the inferior articular processes which originally were an integral part of the vertebra involved. Left behind are those parts of the vertebra posterior to the defect, namely the inferior articular processes, the laminae, and the spinous process. These latter structures remain in juxtaposition and in normal relationship to the superior articular processes of the vertebra below.

Pheasant and Swenson (2) found only two cases of unfused neural arches in 171 spines dissected for study of the lumbosacral region. Protrusion or herniation of the disk is rarely associated with this condition except where we are dealing with a severe grade of spondylolisthesis. Occasionally the intervertebral disk may show some thinning. Müller's case of congenital absence of the inferior articular processes of the 2nd lumbar vertebra without resulting spondylolisthesis is of interest. That anterior or posterior displacement did not occur is probably to be explained by the fact that the upper lumbar spine does not present the obliquity character-

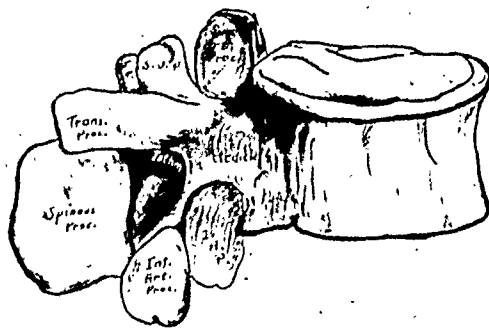


Fig. 3. Sketch of normal 5th lumbar vertebra, showing in particular the superior and inferior articular processes, the pedicles, and the isthmus.

istic of the area of the 5th lumbar vertebra; also that the 2nd lumbar vertebra rests flatly and securely on the 3rd lumbar, so that this region is subject to less shearing strain.

The paravertebral soft tissue structures of the area are then called upon for added support and as a result stretch and thicken. If the soft tissue structures, namely the surrounding ligaments, are equal to this added task and the lumbosacral angle is within normal limits so that shearing strains can be minimized and there is no superimposed sudden or even gradual traumatic effect, there will be no forward slipping of the spine. The circumstances incidental to the individual case will decide whether or not slipping is to occur. Suffice it to say that the existence of this defect, even though it be unilateral, presents the picture of prespondylolisthesis prior to slipping. When slipping has occurred, we pass on to the phase of spondylolisthesis. After the spondylolisthesis develops, if the degree of forward displacement is sufficient, the intervertebral disk may be dislocated and undergo progressive degeneration. Thus nature attempts to utilize the dislocated disk as a buttress to prevent, by calcification and ossification, further progression of the slipping.

Meyerding (3) conveniently divides the articular surface of the sacrum into four transverse planes, the first traversing the posterior fourth and the last the anterior fourth of the articular surface. If the

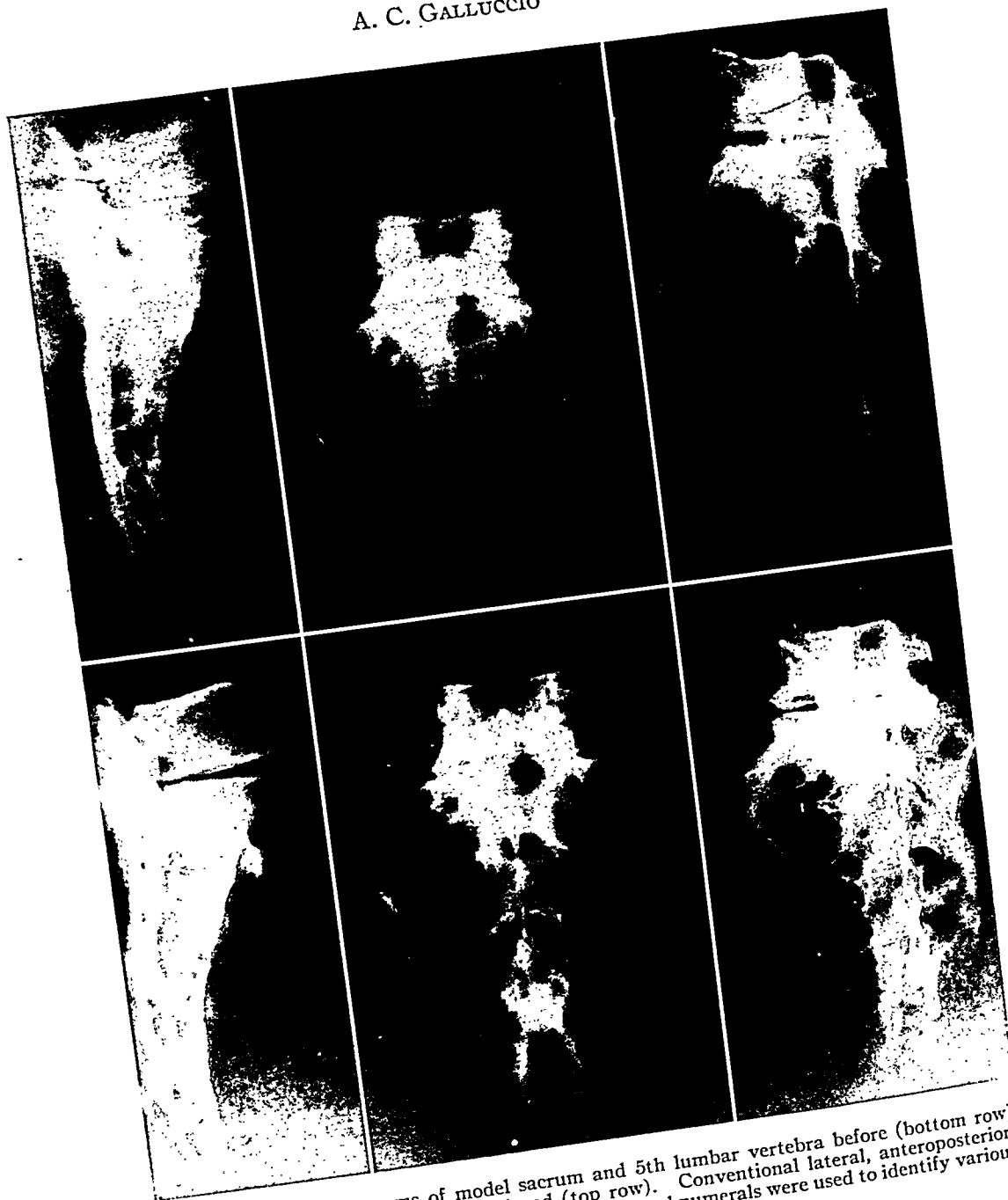


Fig. 4. Roentgenograms of model sacrum and 5th lumbar vertebra before (bottom row) and after defect was artificially produced (top row). Conventional lateral, anteroposterior, and oblique views shown in the order mentioned. Lead numerals were used to identify various structures.

postero-inferior angle of the anteriorly displaced vertebra lies within this posterior or first segment, the displacement is referred to as a Grade I spondylolisthesis. If it lies in the third segment, the case is one of Grade III spondylolisthesis, and so on. As Meyerding further suggests, an injury during birth or shortly after may produce a bone infarct with consequent softening and later a picture strongly suggestive of

osteochondritis. We have found that the appearance of some of the isthmic zones tends to corroborate this possibility, as we have noted fragmentation with increased density of the fragments.

*Genesis:* With respect to the genesis of spondylolisthesis there is considerable difference of opinion. Most of the earlier workers have based their interpretation of this defect upon the presence of five

centers of ossification; one for the body and two for each lateral mass. Willis (4) accepted this view and went on to claim that of the two lateral masses one forms the pedicle and superior articular facet, while the other is concerned with the ossification of the lamina and inferior articular facet. If failure of these two structures to unite occurs, a defect is produced with consequent separation of the body from the posterior neural arch. Neugebauer was of the same opinion but attributed most cases to injury. George (5) believes the defect to be developmental in origin. He mentions two patients with typical spondylolisthesis who married and had two children. One of the latter, now twenty-one years of age, shows an incomplete sacralization of the 5th lumbar vertebra and the other shows a prespondylolisthesis of the 5th lumbar vertebra. No one has been able to produce evidence that inflammation is an etiological agent, although Killian believed the process to represent a caries.

In favor of a congenital origin the argument has been advanced that at the time of operation no callus is found. Furthermore, the literature does not show one case of spondylolisthesis following trauma in which earlier films revealed a perfectly normal spine. It is also argued that, since 25 per cent of the cases are unilateral, fracture or injury cannot be the cause. The fact that associated developmental defects may be found is another argument advanced as favoring a congenital origin. George (5) in a series of 3,301 patients seen at the New York Orthopedic Dispensary and Hospital with signs and symptoms referable to the spine found the incidence of spondylolisthesis and prespondylolisthesis to be 3.5 per cent. He believes that this figure in comparison with other reported figures would suggest that neural arch defects occur in many instances without producing symptoms. Willis (4) admits that the fact that defects exist without symptoms, and that symptoms usually follow trauma, would indicate that the defects are predisposing rather than direct

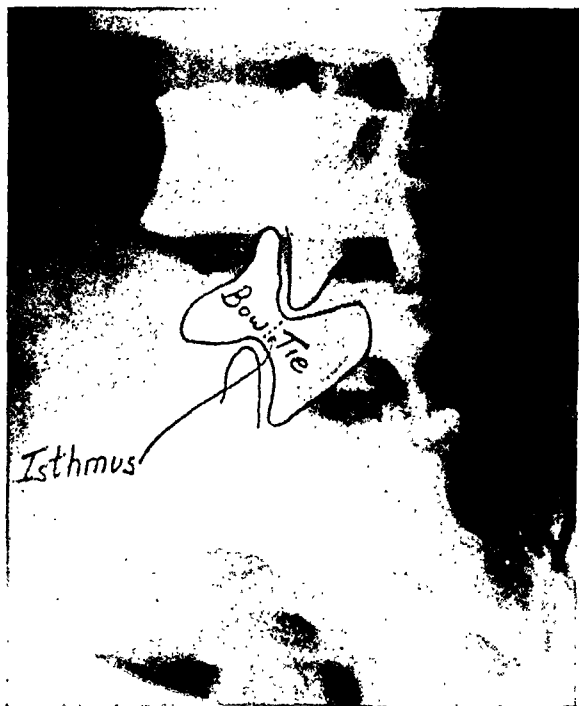


Fig. 5. Normal oblique view for purpose of demonstrating "bow-tie" appearance of the combination of the following structures of the 5th lumbar vertebra: superior articular process, inferior articular process, and connecting portion, the isthmus. The relationship of both the superior and inferior articular processes to the articular processes of the 4th lumbar vertebra above and the 1st sacral segment below, is also indicated. Parts sketched in for demonstration purposes.

etiological factors. He holds that the absence of any obvious attempt at union would tend to rule out fracture as a cause.

Hitchcock (6) states that the work of Rambaud and Renault, who described the existence of five centers of ossification for each vertebra, has not been substantiated. Batts (7) challenges the congenital theory by stating that, if the separated neural arch occurs in 5 per cent of fully developed skeletons, it should also be found in approximately 5 per cent of fetal or newborn skeletons. He believes that there are three centers of ossification—not five—and that the centers for the posterior neural arch fuse at term or shortly thereafter. Failure of fusion results in spina bifida. The neural arch becomes fused with the body of the vertebra from the fourth to the sixth year. Mall, Willis, and Chandler were unable to find any evidence of double or anomalous centers of ossification in a series of 200

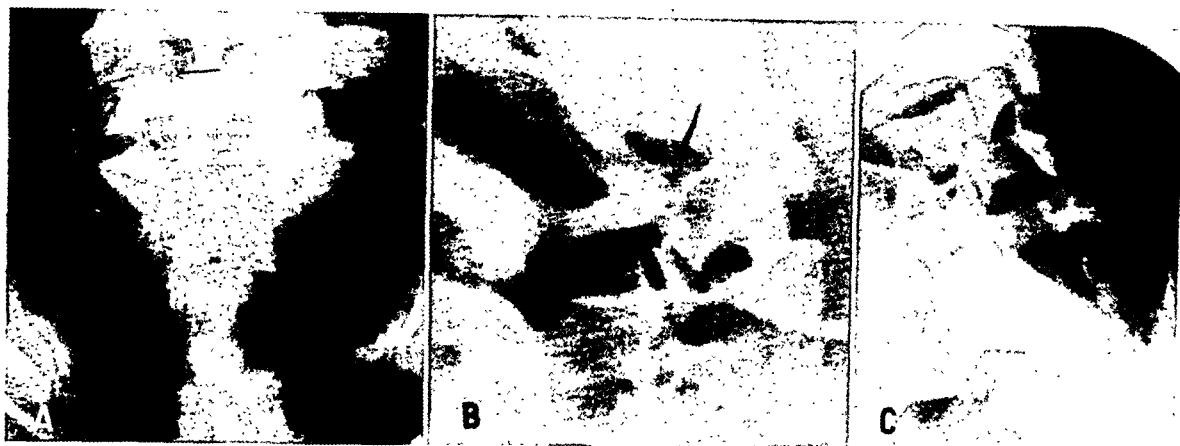


Fig. 6. Unilateral prespondylolisthesis.

A. Anteroposterior view showing linear defect (arrow) on right side. Note that the defect line is immediately below the pedicle seen on end and that its medial portion is slightly higher than its lateral portion. Note absence of similar line on contralateral side.

B. Right oblique view, indicating site of defect.

C. Left oblique view, showing normal isthmus on left side.

fetal spines, ranging in age from three months to term. Meyerding believes that trauma is the exciting cause but that underlying it in most instances is a defect, so that injury may be considered the principal etiological factor and a congenital lesion the anatomical or predisposing factor. Chandler (8) quotes Hibbs and Swift as reporting a history of injury in 49 per cent of 23 cases. He makes a very pointed criticism of roentgenologists for not insisting on good films which will reveal the details of all bony structures at the lumbosacral junction. He further questions the peculiar coincidence of the site of "congenital clefts" and the point of maximum shearing strain of the isthmus and suggests the possibility that some of these "clefts" may in reality be fractures sustained during early childhood. Brailsford (9) cites as many as 23 workers who differ as to the etiological agent of this condition. He is of the opinion that pregnancy does not influence or predispose to the development of spondylolisthesis.

The author believes that the work of Hitchcock and his explanations of his findings must be considered seriously. His observations, based on a study of 90 human fetuses ranging in age from six weeks intrauterine life to term, show that each vertebra ossifies from three centers. Ossification of

each half of the neural arch commences at the base of the articular process close to the isthmus. The laminae are formed a little ahead of the pedicles. A double or defective center was never found. Hitchcock goes on to describe the isthmic region as remaining cartilaginous up to and after birth. He also raises the question as to why, if the defect is congenital and has been found to exist in 5 per cent of 2,000 cases, one cannot find even one anomalous or defective center of ossification in fetal material. One must assume that the defect is *not* congenital, although most orthopedists hold it to be. He further states that the isthmic area is occupied by blood vessels almost sinusoidal in character, which weaken this particular region.

Hitchcock experimented with stillborn infants ranging from eight months to term and cadavers up to ten months postnatal. He found that moderate hyperflexion readily fractured the neural arch in the lower lumbar region. Most of the fractures were bilateral, but he was able to produce unilateral fractures by combining flexion with lateral bending and some torsion. Flexion, as he points out, is more limited in extent ( $12^\circ$  from the perpendicular) than extension ( $25^\circ$  from the perpendicular). Attempts at hyperextension failed to produce fracture, but forced

hyperextension resulted in tearing of the anterior longitudinal ligaments and separation of the vertebral bodies. The conclusion is reached that in hyperflexion the anterior margins of the vertebra act as a fulcrum. Hitchcock's findings serve to strengthen the traumatic theory of the origin of spondylolisthesis. According to his theory, flexion applied during delivery or shortly after birth, for resuscitation or stimulation, may produce fracture, with



Fig. 7. Anteroposterior views of two cases, showing location and roentgenographic appearance of defect.

subsequent union by fibrous tissue or cartilage and the development of a pseudarthrosis.

**Symptoms:** Many cases (10 per cent) of unilateral and even bilateral spondylolisthesis are asymptomatic, the lesion being found accidentally. This was so in 4 of the cases here presented. In other instances there may be complaint of low back pain, weakness, fatigue, or stiffness in the lower back. The pain may be localized in the low back or radiate to the hip, buttocks, coccyx, and even down the leg or along the course of the sciatic nerve. Meyerding (3) states that backache was the chief complaint of more than 80 per cent of 583 patients. Relief of backache



Fig. 8. Anteroposterior and lateral views showing defect. This is particularly well shown in the lateral view (arrow).

by rest in the recumbent position is a fairly common finding. Kleinberg (10) states that sudden muscle strain may result in edema and hemorrhage at the site of the defect, causing pressure on the sciatic nerve, producing a sciatic syndrome. He further states that lordosis is usually present. We found several instances of loss of normal lordotic curvature in the low lumbar spine area. This is, however, only an apparent loss and is due to the fact that the sacrum appears to lie more posteriorly and the normal lordotic curvature is shifted slightly cephalad. Local pressure and motion aggravate the pain, and spasm of muscles tends to resist movement and therefore results in limitation of motion. In bilateral lesions one may find acute tenderness over the spinous process and in advanced cases this may occasionally be moved from side to side. This is certainly the experience of orthopedic men who have come upon a bilateral defect at the operating table. A prominent spinous process of the 5th lumbar vertebra is often present.

Neurological examination is usually nega-



tive. It is a common experience to have a patient complain of low back pain following injury, either single or multiple, often trivial in nature. In such cases trauma is definitely an exciting factor which probably aggravates a pre-existing condition, such as prespondylolisthesis. Spondylolisthesis *per se*, if of minimal grade or degree, may occasionally be asymptomatic, but most patients will have definite com-

tion. With improved technical methods for a complete study of the lumbosacral spine and a thorough knowledge and comprehension of the anatomy of the region and of the defect involved, most cases should be discovered. Films of good technical quality, particularly lateral views of the lumbosacral area and the right and left oblique views, are extremely important. We have found that the defect may

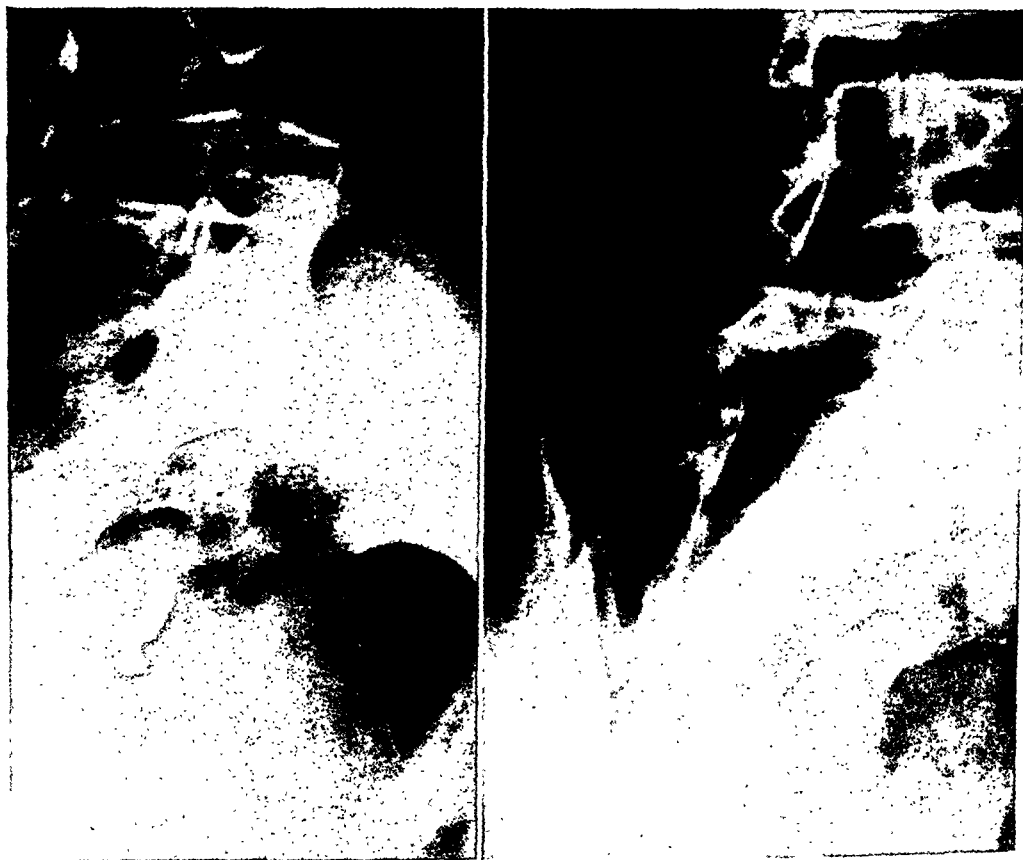


Fig. 9. Left and right oblique views, demonstrating a dissolution of continuity in the isthmic portions bilaterally. Superior articular process of 1st sacral segment is seen jutting into the area of dissolution (isthmic area).

plaints referable to the low back, as described above.

**Diagnosis:** Neugebauer aptly states that "it lies with anatomists and pathological anatomists and those who make surgical and forensic postmortems, to look out for the early stages of spondylolisthesis and all cases of injury from falls." The roentgenologist must definitely be included in the group charged with discovering the early stages of this condi-

tion. Case, working on a model of the pelvis embedded in paraffin, showed that unless the central ray is directed over the defect it will not be demonstrated. This probably accounts for occasional failures.

Our method of routine study of the lumbosacral area includes the following views: anteroposterior; direct and accurate lateral; right and left anteroposterior oblique; lumbosacral angle view (45° tilt).

In the anteroposterior view the defect appears as a dissolution of continuity lying just below the circular shadow produced by the pedicles seen on end. In this view the line of defect is slightly higher medially than laterally—a difference of a few millimeters. The lateral limitation of the line of defect is usually just below the attachment of the transverse process to the body. Occasionally the line of defect is horizontal. It is seldom a complete straight line; usually it is irregular, measuring about 1 mm. or slightly more in width. This defect may be unilateral or bilateral. It may exist and not be apparent on an anteroposterior film unless the central ray is aimed directly through the plane of the defect. Occasionally the lumbosacral space (angle) view reveals a defect which is not seen in the anteroposterior view.

The right and left oblique views are extremely important for diagnosis, for it is seldom that, given a film of good technical quality in a case in which the defect exists, it cannot be demonstrated. We like to refer to the superior articular process, the pars interarticularis, and the inferior articular process of any one lumbar vertebra as presenting, in either oblique view, a so-called "bow-tie" appearance. The superior and inferior articular processes constitute the lateral portions or the wings of the "bow-tie," while the pars interarticularis, or isthmus, is represented by the central or constricted portion. This is a constant appearance in both oblique views. The "bow-tie" usually extends from the upper portion of the middle third of the body of the involved vertebra downward and backward to the isthmus zone and from this point more directly downward and less directly posteriorly. The inferior portion crosses the posterior third of the intervertebral space between the lumbar vertebra to which the "bow-tie" belongs and the next lower lumbar vertebra. In the right oblique view the "bow-tie" pattern, representing the right superior and inferior articular processes, will lie posteriorly, well behind and below the body and inter-

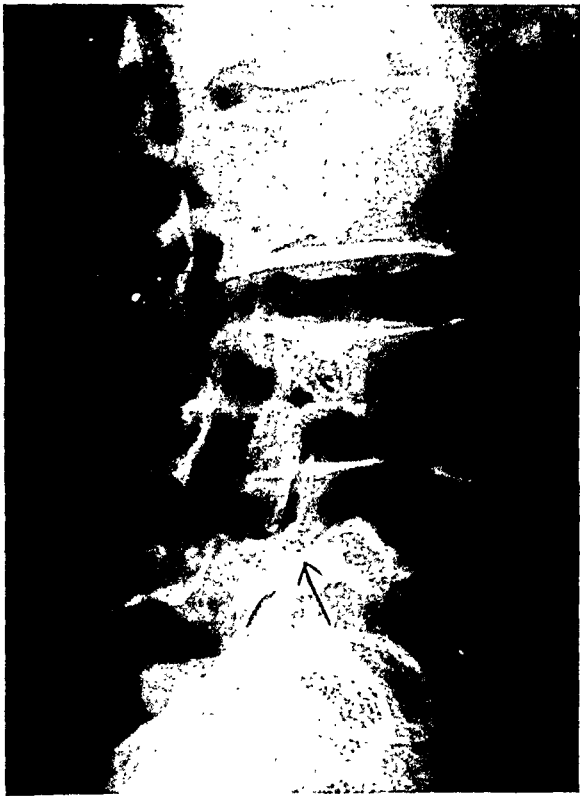


Fig. 10. Oblique view, demonstrating typical defect in isthmus portion, with fragmentation and sclerosis. This type of roentgenogram makes one wonder as to the possibility that osteochondritis may play a part in this entity.

vertebral foramina. In this view the spinous process of the lumbar vertebra is the most posterior structure. In the left oblique view, the left superior and inferior articular processes will occupy the position described above; namely, traversing the middle and posterior thirds of the lumbar vertebra, while the right superior and inferior articular processes will lie posteriorly. It is understood that slight rotation of a few degrees, anteriorly or posteriorly, of the lumbar spine will result in throwing the "bow-tie" slightly anteriorly or posteriorly, depending on whether the degree of obliquity is greater or less. A study of the film depicting the 5th lumbar vertebra and sacrum with the artificially induced defect of the pars interarticularis will serve to clarify the location of the various structures. It is the oblique view which best reveals the isthmus zone or pars interarticularis.

For the lateral view it is important that

the patient lie exactly perpendicular to the plane of the film. Here the defect will be seen as a more or less horizontal or slightly tilted straight line traversing the pars interarticularis, and lying below and behind the pedicle of the vertebra involved. The upper posterior angle of the intervertebral foramen lying between the involved vertebra and the vertebra below will mark the anterior limit of this straight line. From this point the defect can be followed

standable why the line of defect will not be clearly demonstrated. In these cases it is desirable to take both a right and a left lateral view.

We wish to emphasize that inconsistency in demonstration of the defect in the various views, that is to say, ability to demonstrate it in one view and not in others, should not cast doubt upon its existence, but is to be explained on the basis of failure of the direct central ray to catch the



Fig. 11. Lateral views of 2 cases, revealing defect below and behind the postero-inferior angle of the pedicle.

posteriorly. It is essential, as previously noted, that lateral films be of good technical quality. Coning and immobilization of the patient are of great help. We concede that a lateral view taken in the erect position, as well as one in the recumbent position, may occasionally be of assistance in demonstrating further slipping. A good lateral recumbent film, however, is generally considered sufficient. If the defect is unilateral, say limited to the right side, and a left lateral view is taken, it is under-

plane of the lesion. The complex structure of the region involved, plus the frequent occurrence of anatomical variations, renders it almost impossible invariably to traverse the defect so that it can be demonstrated. This is one reason why multiple views are strongly recommended. The lumbosacral angle view, taken with the central ray directed 45 degrees cephalad and emerging through the lumbosacral space, is occasionally of value, since in this view the inferior articular processes

may be seen through the intervertebral space. In this way the superimposition of the body is sometimes avoided. This view is also of some assistance in those cases in which the articular space between the facets may simulate a defect, particularly if the plane of articulation lies in a coronal-oblique direction. In the lumbosacral view the plane of articulation between the superior and inferior facets will come to lie within the intervertebral space

strate. The above description of the various views, while necessary, can almost be discarded if one has access to a model of the lower lumbar spine and sacrum and becomes thoroughly familiar with all the structures involved, and knows how and where they will appear on the film in the various positions mentioned. We have described the defect and its exact location and extent to some length because we feel that a thorough knowledge of these mat-

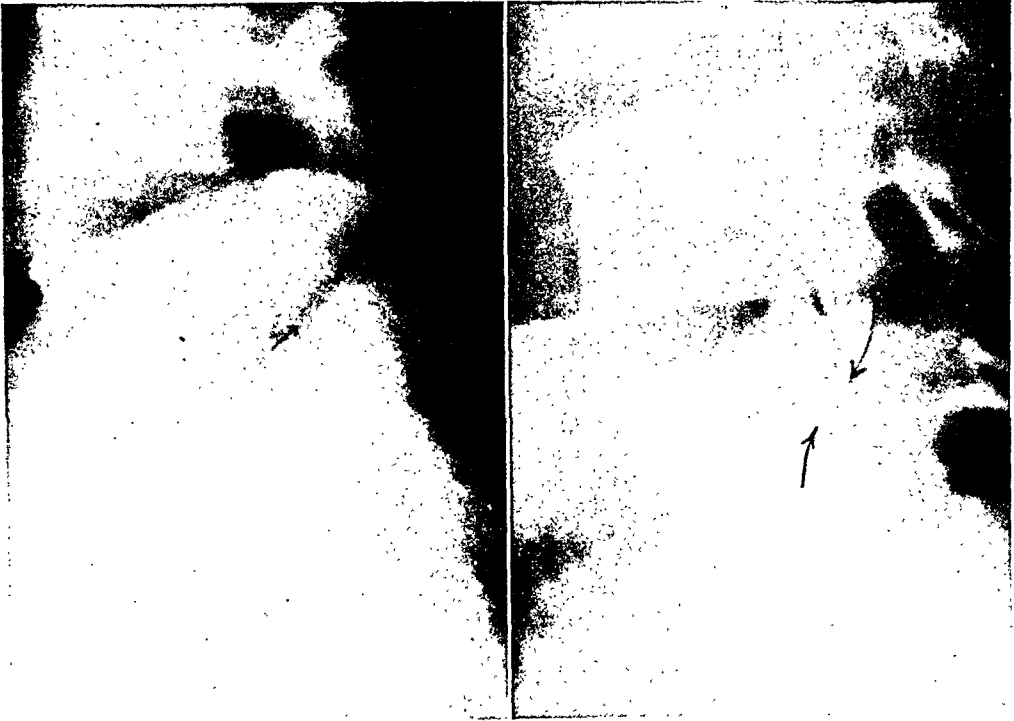


Fig. 12 (left). Lateral view showing definite linear defect below and behind the pedicles of the 5th lumbar vertebra. The width of such a defect may vary from 1 to several millimeters.

Fig. 13 (right). Oblique view demonstrating typical defect, in this case a smooth one, through the isthmus portion of the "bow-tie" area.

or fairly close to it, so that it is more clearly demonstrated. This is an important point to remember, namely that one must not confuse the joint space between the two articulating processes with a defect when the latter is being sought.

It is our opinion that the most important views are the anteroposterior, the right and left oblique, and the true lateral. It cannot be too strongly emphasized that films of excellent technical quality are of paramount importance, as this defect is very often elusive and difficult to demon-

ters will help reveal numerous cases of pre-spondylolisthesis which are unsuspected and which, in our opinion, if the defect is bilateral, will ultimately go on to spondylolisthesis with its characteristic crippling effects. We strongly urge that all films of the abdomen for purposes other than spine study receive the attention of the roentgenologist with reference to the 4th and 5th lumbar vertebrae, and that a search be made beneath the pedicles for a defect line.

Brailsford (9) refers to a "bowline" as



Fig. 14. Anteroposterior view which reveals bilateral defects beneath the on-end shadows of the pedicles. Note that the medial ends of the defect lines lie more cephalad than the lateral extremities of these lines. The lower arrow indicates site of apophyseal joint space. This may occasionally offer difficulty in differentiation but if it is remembered that the medial portion of a true defect line is always higher in relationship to its lateral portion, the differentiation should be fairly easy in most cases.

being characteristic of spondylolisthesis. This is present fairly often in the anteroposterior view and represents a converging of the inferior and lateral aspects of the slipped 5th lumbar vertebra with the inferior and lateral aspects of the transverse processes of this vertebra. Since most of our cases were either prespondylolisthesis or first-grade spondylolisthesis, we were unable to demonstrate this characteristic appearance. We have seen it, however, in more advanced cases and it may be considered of value in the diagnosis of this condition.

*Differential Diagnosis:* We are of the opinion that accurate, painstaking examination of the lumbosacral area in the positions above outlined, with films of good technical quality, will leave little difficulty in distinguishing this lesion from other

possibilities. Fracture dislocations, Kummell's disease (an entity of which we have some doubt), Pott's disease, malignant neoplasm, congenital dislocation of the hip, and osteomalacia are occasionally to be considered as diagnostic possibilities. Whether due to misguided confidence or sheer good fortune, we have not had to consider too seriously any of these before arriving at a definite diagnosis of spondylolisthesis.

At this writing, 2 of our 5 cases of spondylolisthesis have been verified at operation. Spine fusions were done.

*Treatment:* Treatment, we feel, belongs to the realm of the orthopedist. For purposes of completeness, however, we may say that spine fusion is considered adequate and curative treatment for frank spondylolisthesis. We need not enter into a discussion of the various types of fusion. It is interesting to note that an English orthopedist describes a method of obtaining reduction of a forward displacement of the 5th lumbar vertebra by suspending the patient on a sling around the pelvis, with another sling placed below the shoulders, plus traction on the legs. He reproduces roentgenograms to show the reduction obtained by such a method. Conservative treatment, such as frequent physiotherapy, postural exercises to reduce lumbar lordosis, use of a firm bed, and support with a belt, will be followed by symptomatic relief in about one-third of the cases.

#### SUMMARY

The terms prespondylolisthesis and spondylolisthesis are defined and differentiated. In the former, we have the presence of a defect in the neural arch. In the latter, we find separation at the site of defect and slipping of the lumbar vertebra involved. An unusually high rate of incidence—10 per cent—is represented by the relatively small series of cases recorded here. Over 50 per cent of the cases were prespondylolisthesis, 4 of these being discovered in films not intended for spine study. One explanation of the high incidence is

the fact that soldiers constitute an age group characteristic of this condition and are subject to unusual hazards and strains. The natural weakness of the lumbosacral area is definitely exaggerated by any superimposed weakness, such as the defect here described.

The cause of the defect in the posterior neural arch, specifically in the pars interarticularis area, is not definitely proved.

acter of the defect. We believe that its discovery is of great importance in both civilian and military life, since its presence means a weak link in a not overly strong chain. Certainly with unusual and often with ordinary strains and hazards, separation may develop, and from this point it is a short step to actual forward slipping of the vertebra. The literature is replete with cases demonstrating the progressive



Fig. 15. Two cases of posterior or reverse spondylolisthesis of 5th lumbar vertebra on 1st sacral segment.

One group considers it congenital and another the result of trauma. We are inclined to concur with the opinion expressed by Hitchcock (6), namely, that there is a strong possibility that the defect is not congenital, but rather traumatic in origin.

Symptoms may be present and may be fairly characteristic, but the diagnosis can seldom be made from the clinical picture alone. Roentgenograms are essential to the conclusive diagnosis. It is for this reason that we have described and illustrated in some detail the location and char-

acter of this slipping action with eventual frank spondylolisthesis. The crippling nature of this latter condition must be at once apparent. If the lesion is detected early, precautionary measures may be directed toward prevention of its further progress. Apropos of this, however, one observer mentions progressive forward slipping in spite of a supporting belt and avoidance of strain.

Films of good technical quality, particularly oblique and lateral views, are essential. Demonstration of the "bow-tie" area in the oblique view is necessary if

the site of the lesion or defect is to be apparent. We wish once again to emphasize the importance of constantly looking for this condition in both civilian and military life, the progressive character of the disease, and its possible medicolegal importance.

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## BIBLIOGRAPHY

1. MEYERDING, H. W.: Spondylolisthesis. *Surg., Gynec. & Obst.* 54: 371-377, February 1932.
2. PHEASANT, H. C., AND SWENSON, P. C.: The Lumbosacral Region: Correlation of Roentgenographic and Anatomical Observations. *J. Bone & Joint Surg.* 24: 299-306, April 1942.
3. MEYERDING, H. W.: Spondylolisthesis as an Etiologic Factor in Backache. *J. A. M. A.* 111: 1971-1976, Nov. 26, 1938.
4. WILLIS, T. A.: Backache from Vertebral Anomaly. *Surg., Gynec. & Obst.* 38: 658-665, May 1924.
5. GEORGE, E. M.: Spondylolisthesis. *Surg., Gynec. & Obst.* 39: 774-781, April 1939.
6. HITCHCOCK, H. H.: Spondylolisthesis: Observations on Its Development, Progression, and Genesis. *J. Bone & Joint Surg.* 22: 1-16, January 1940.
7. BATTS, M., JR.: Etiology of Spondylolisthesis. *J. Bone & Joint Surg.* 21: 879-884, October 1939.
8. CHANDLER, F.: Lesions of the Isthmus (Pars Interarticularis) of the Laminae of the Lower Lumbar Vertebrae and Their Relation to Spondylolisthesis. *Surg., Gynec. & Obst.* 53: 273-306, September 1931.
9. BRAILSFORD, J.: Spondylolisthesis. *Brit. J. Radiol.* 6: 666-684, November 1933.
10. KLEINBERG, S.: Low Back Pain and Sciatica Secondary to a Strain in Prespondylolisthesis of the 4th and 5th Lumbar Vertebrae. *Am. J. Surg.* 45: 584-586, September 1939.
11. BLEWETT, J.: Cases of Spondylolisthesis of Unusual Interest. *Brit. J. Radiol.* 13: 416-421, December 1940.
12. MITCHELL, G. A. G.: Radiographic Appearances in Spondylolisthesis. *Brit. J. Radiol.* 6: 513-529, September 1933.
13. MEYERDING, H. W., BAKER, G. S., LOVE, J. G., AND CAMERON, D. M.: Spondylolisthesis with Protrusion of Intervertebral Disk and Hypertrophied Ligamentum Flavum Associated with Multiple Loose Bodies (Osteochondromatosis) of Right Shoulder Joint: Report of Case. *Proc. Staff Meet., Mayo Clin.* 14: 801-806, Dec. 20, 1939.



# Castration in Malignant and Non-Malignant Disease<sup>1</sup>

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IT APPEARS THAT sex hormone production is reduced or inhibited after irradiation castration and following surgical ablation of ovaries or testicles. When the growth-stimulating influences of sex hormones are withdrawn, clinical observations show definite alterations of certain pathological conditions. There also follow certain histological and physiological changes which influence the general state of health and may be concerned with both the origin and the progress of malignant disease.

Human castration of the male by orchiectomy, creating defective masculinity, has been practised from remote antiquity by some Orientals. Historical records indicate that great numbers of eunuchs were created in ancient Egypt, Greece, and other countries both for religious and secular purposes. In fact, the demand for the high-pitched falsetto voice in a man singing in religious ceremonies has been abandoned only within recent years. When the earliest records were compiled, it was recognized that not only was fertility terminated by castration, but that certain other abnormal changes ensued, affecting growth and mental development.

Recent medical research has explained some of the phenomena of castration and it is my purpose to call attention to a few of the phases which concern us in the control of disease.

Castration may be performed in the human being (15, 16) for two purposes: first, to halt fertility; second, to induce specific changes, particularly in the endocrine system. Two methods are employed, the surgical and the radiological. In surgical castration it is intended that the entire influence of the testicle or ovary be terminated by complete ablation

of the organ, while in radiological castration certain components of usefulness may be retained while those whose elimination is essential to accomplish the desired purpose are destroyed.

Two classes of disease will be considered—malignant and non-malignant—both of which are in some way influenced by the activity of the sex organs. One of the most essential objects of castration is to modify the action of the growth-stimulating hormones—estrone in the female and androsterone in the male. The true role played by these important hormones in physiological processes essential to the proper development and maintenance of health is rapidly being elucidated through experimental investigations on animals and in clinical research.

Changes, both objective and subjective, appearing in the breasts with menstruation have long been recognized and studied. These have taken on a new significance since Rosenberg (1) discovered and interpreted the mechanism of the sex cycle in the breast. Ingleby (2) writes: "The sex cycle in the breast was discovered by Rosenberg in 1922. A revolution in the interpretation of pathological lesions followed. Proliferation of glandular elements during the premenstrual phase is far more rapid than the growth of any carcinoma. Their postmenstrual regression is equally astonishing—for after a few days only traces of former lobules remain in the form of one or two clefts barely visible in the connective tissue which has closed in and obliterated the site of the glandular mass." After castration, as also following the natural menopause, this periodical and phenomenal proliferative and regressive tissue change ceases and the other phases of the climacterium ensue.

That the ovarian hormones exercise a definite influence on the histologic and

<sup>1</sup> Presented before the Radiological Society of North America, at the Twenty-eighth Annual Meeting, Chicago, Ill., Nov. 30-Dec. 4, 1942.



physiologic character of the breasts during the sex life of the individual has been accepted without question. It is not so clear, however, just what can be accomplished at present by modifying these conditions through castration.

In the male, castration exerts an influence upon the prostate that is somewhat comparable to that on the breasts in the female, for it seems that the physiological growth variations in both are to be explained on a hormonal basis. While it is not certain that a definite cyclic proliferation of prostatic epithelium occurs, true hypertrophy is observed in a high percentage of males in later life when testicular function has not been reduced. If testicular function is lost, then hypertrophy does not proceed in the regular way.

The male sex hormone—androsterone—is known to stimulate growth of the prostatic epithelium. Probably the principal sources of androgen are the interstitial tissue of the testicles and the adrenal glands. It has also been shown that by administering the female sex hormone—estrone—the growth of prostatic epithelium may be inhibited. Through research on sex hormone action, facts have evolved which tend to explain and give a scientific basis for some clinical observations that have been difficult to understand.

Another striking example of hormonal influence on tissues is the reaction of the endometrium to the ovarian hormones in the various phases of the menstrual cycle. It is notable that endometrial tissue in ectopic locations, *i.e.*, the oviduct, surface of the ovary, or elsewhere in the female pelvis, responds to the same hormone stimulus as in its normal location. Castration is followed by cessation of this local growth tendency, with the result that the cyclic periods of cellular proliferation of the endometrium and subsequent regressive changes promptly discontinue.

Great impetus has recently been given the study of the results of castration in man. Kutscher and Wolbergs (3) and Gutman and Gutman (4) have made ex-

tensive studies of acid phosphatase concentration in the serum and certain tissues of the body. In the prostate low values were found in children, becoming slightly higher through puberty and high in the adult. Huggins and his collaborators (5-7) continued these investigations and confirmed the findings by the use of staining methods for acid phosphatase in the prostate. They also found that the enzyme phosphatase of the adult prostate paralleled in quantity the extent of the hypertrophy as well as the amount of carcinomatous change that had taken place in the organ. These findings, with others, led them to conclude that the cells of prostatic carcinoma, in their cases, were of adult type rather than the primitive undifferentiated type usually found in malignant neoplasms. They have recorded another finding which appears useful, having found the serum-phosphatase level to remain within the bounds of normal in hypertrophy and localized cancer of the prostate, but to be greatly altered in the presence of bone metastases. When the estimates were high, metastasis had invariably occurred, though a few cases in their series showed only low levels even with secondary deposits present in the skeleton. It is obvious that high levels are almost positively diagnostic of bone metastasis. Another significant development in the work of Huggins and his associates was the demonstration that these mature types of cells from the prostate in ectopic locations retained androgen sensitivity, which is analogous to the estrogen sensitivity of cells of ectopically located endometrial tissue in the female. It was further demonstrated that when androgen-stimulated hyperplasia was reduced, evidence of local repair of bone lesions followed. Furthermore, when the androgen stimulus was withdrawn in these cases, clinical improvement occurred promptly and longevity was extended.

This research has demonstrated beyond the criticism of the most skeptical that the withdrawal or regulation of the androgen effect on certain tissues constitutes an-

other very definite step in the control of cancer. Just how we should undertake to alter this androgenic effect remains undecided. Huggins and his co-workers believe that orchiectomy gives the best result. While they report a certain amount of discomfort and some undesirable reactions, they still feel that the results justify this surgical measure. Improvements which they noted in certain far-advanced cases seemed most gratifying. In this group of patients, high serum-phosphatase levels were reduced to the range of normal values in a matter of hours. In the group where clinical improvement was slight or unchanged, the serum-phosphatase levels were only slightly altered. It was concluded that under these circumstances androgen was being produced at loci other than the testicle. In these cases the investigators attempted the reduction of androgen by the action of estrogenic agents (stilbestrol). Here they found that some of the cases responding poorly to surgical treatment presented favorable results, and in some, marked clinical improvement was observed, with the acid phosphatase levels reduced to a par with the most favorable group following orchiectomy. Their experiences with fever therapy were not encouraging.

Reporting on "The Effect of Orchiectomy and Irradiation on Cancer of the Prostate" in a recent issue of the *Annals of Surgery*, Huggins presents two cases in which radiation was given a trial. In one case, high-voltage x-rays (800 kv.) with high filtration, used over four portals (anterior, posterior, and two lateral hip portals), produced symptomatic relief for two months. When the symptoms recurred, a second series was given, with the testes unscreened. This time the relief of symptoms lasted for about six weeks. Rectal examination showed the prostate to be nodular and greatly enlarged, and roentgenograms revealed osteoplastic metastases in the right side of the pelvis. Orchiectomy was then performed.

Another case was similarly treated but with somewhat lower voltage (200 kv.

constant potential). The testicles were protected with lead rubber. A second exposure was given six months later without the lead rubber protection. General clinical improvement was noted and the prostate gland remained hard and nodular. Orchiectomy was performed three months later, with prompt symptomatic relief and reduction in the size of the prostate gland.

The pathological report in both these cases showed profound atrophy of the germinal epithelium with preservation of the Sertoli cells and apparent or real hyperplasia of the Leydig cells. Huggins concludes: "It was thus apparent that roentgen ray irradiation in the amounts stated is ineffective in destroying the secretory function of the testicles and is inadequate as a therapeutic agent in prostatic cancer in man." Based on the microscopic findings, the conclusion is that, by irradiation, germinal epithelium of the testes was profoundly affected, but the interstitial tissues from which androgenic agents are derived was unaffected.

Munger (8) reported a series of 76 cases of carcinoma of the prostate treated by resection, planned x-ray therapy (without protection of the testicles), and adjunct or additional irradiation directly to the testicle. The cases reported were observed over a period of five years ending December 1938. At the time of the report (May 1941) 51 patients were known to be dead and 18 were known to be alive. Of 12 patients in whom resection alone was done, all died; of the group of 45 treated by resection and irradiation, 10 were alive; of the 11 treated by resection, irradiation, and adjunct x-ray therapy, 8 were still alive. This latter group showed prostatic recovery on digital physical examination. The longest period of survival was seven years; the shortest was three years.

Estrogens, it is believed, reduce the serum phosphatase in carcinoma of the prostate in the following ways: (a) direct action on prostatic epithelium; (b) neutralization of androgen; (c) depression of the gonadotropic agents from the anterior

lobe of the pituitary gland; (d) depression of the activity of the interstitial cells of the testicles. It appears that both the epithelium and the interstitial cells of the testicles show hypoplasia as a result of estrogen administration, and it also seems that this effect is more or less temporary. It has not been ascertained that benefits resulting from orchiectomy are permanent because, if for no other reason, the cases have not been observed for sufficient length of time in the light of modern clinical and diagnostic methods.

While the androgen-producing cells of the testicles were not adequately depressed by x-rays in the work that has been reported, and the results of efforts to control the androgens produced at points other than the testicles are but temporary, there may yet be a useful place for radiotherapy in these locations, *i.e.*, the adrenal, the pituitary, etc. The first objective in treatment of carcinoma of the prostate would seem to resolve itself into an effort to reduce or withdraw androgenic effects entirely, if possible.

As we acquire knowledge of the growth effects and influences of the sex hormones, there appear interesting points of analogy, the study of which may be helpful and elucidating. An outstanding similarity is that of the cells in metastatic deposits from carcinoma of the prostate and those of the endometriomata or ectopically located endometrial tissue. In each instance the cells are of the mature type, and in each sensitivity is retained for the respective sex hormone; estrogenic activity is inhibited by androgen administration, and conversely androgen activity is checked by estrogen. Again, ovulation and gametogenesis are restricted temporarily or arrested permanently by controlled doses of irradiation. Finally, the relative frequency of myometrial and endometrial hyperplasia shows an interesting analogy to prostatic hyperplasia during the same decades of life.

Hormone control of growth is essential in the normal development of the breasts. Imbalance in early life is certainly re-

sponsible for the unusual hypertrophies, as virginal hypertrophy, gynecomastia, etc. It is only in the later decades of life that hypergonadism carries its cell growth influence beyond benign hyperplasia. Lacassagne (9a) states that carcinoma can occur only in a mammary gland which has undergone a certain degree of development and that this development depends upon the estrogenic and pituitary hormones. He found, also (9b), that excessive amounts of estrogen caused squamous metaplasia of the prostatic epithelium, especially in the posterior lobe and in the verumontanum, and that continued administration to mice resulted in such extreme metaplasia that urinary retention was produced.

Tumors of the adrenal and ovary are known to increase the output of certain ketosteroids in the urine, and recently Satterthwaite, Hill, and Packard (10) noted high levels of the 17 ketosteroids in the urine when prostatic cancer had metastasized to bone. In these cases the output of the 17 ketosteroids showed a drop of 12 to 60 per cent from the pre-operative level after orchiectomy, paralleling closely the changes in the serum phosphatase estimations.

Castration of women to produce an artificial menopause by surgical methods was advocated by Schinzinger (11) in 1889. He also called attention to the benefits experienced by certain patients with carcinoma of the breast, after an artificial menopause. In 1896 Beatson (12) observed shrinkage of the primary breast tumor, reduction or disappearance of skin nodules, and regression of lymph node metastases after the surgical removal of the ovaries.

Foveau de Courmelles (13), in 1907, published reports of castration by irradiation for carcinoma of the breast. This work was begun as early as 1904. Wintz (14) and other radiologists have been using irradiation castration as a part of the treatment of breast cancer since about 1920. Because radiation castration reduces hormonal activity, more may be

expected from this procedure during the period when hormone production is at its peak, *i.e.*, in the third and fourth decades of life. Just when sex hormone production reaches a very low level or ceases entirely following the menopause is not known. It is obvious that its influence on normal cyclic cell growth is decreased or lost entirely late in life, and the factors concerned with neoplasia in the primary and secondary sex organs at this period are probably quite independent.

It cannot be doubted that the hormone status associated with pregnancy and lactation exaggerates malignant disease of the breast. In view of our present knowledge of such cases, the demands for treatment are: first, termination of the pregnancy, preferably by the irradiation method, and if the products of conception are not spontaneously expelled in due time, careful surgical removal; second, preoperative irradiation of the affected breast in all of these early cases, followed by surgical removal and postoperative irradiation of the affected side, as well as of the unaffected breast and axilla. With this plan of management the patient will experience an early menolipsis. It is also advisable to continue irradiation of the pelvis at intervals of sixty to ninety days, until all of the symptoms of the climacterium have ceased, or for at least two years, regardless of symptoms. In all of these cases it is well to administer some androgenic agent, such as testosterone or desoxycorticosterone propionate in daily doses of 10 mg. or more, during preoperative irradiation and at intervals postoperatively.

The prime objectives of this plan of management are: first, to withdraw the estrogenic effects by arresting the principal source of production; second, the interruption of pregnancy, which automatically follows profound alterations in estrogen production; third, a direct radiation effect on functional hyperplasia of the breast epithelium as well as the localized neoplasia; fourth, surgical extirpation of the local disease; fifth, exercise of continued radiation effects over the primary

and the secondary sex organs, as well as control by endocrine therapy for sufficient time to allow these broken functions to return to a state of stability.

In closing, it affords me great satisfaction to know that achievements through scientific medical management now prevent and control many conditions of the primary and secondary sex organs of both the male and female which are so vitally concerned with proliferative and regressive processes. Radiation therapy has contributed liberally.

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#### BIBLIOGRAPHY

1. ROSENBERG, A.: *Frankfurt. Ztschr. f. Path.* 27: 466, 1922; *Virchows Arch. f. path. Anat.* 262: 298-303, 1926.
2. INGLEBY, H.: *Lancet* 2: 835-837, 1932.
3. KUTSCHER, W., AND WOLBERGS, H.: *Ztschr. f. physiol. Chem.* 236: 237-240, 1935.
4. GUTMAN, A. B., AND GUTMAN, E. B.: *J. Clin. Investigation* 17: 473-478, 1938.
5. HUGGINS, C., STEVENS, R. E., JR., AND HODGES, C. V.: *Arch. Surg.* 43: 209-223, 1941.
6. HUGGINS, C., AND HODGES, C. V.: *Cancer Research* 1: 293-297, 1941.
7. HUGGINS, C.: *Ann. Surg.* 115: 1192-1200, 1942.
8. MUNGER, ARBOR D.: *J. Urol.* 46: 1007-1011, 1941.
9. LACASSAGNE, A.: (a) *Am. J. Cancer* 37: 414-424, 1939; (b) *Compt. rend. Soc. de biol.* 113: 590-592, 1933.
10. SATTERTHWAITE, R. W., HILL, J. H., AND PACKARD, E. F.: *J. Urol.* 46: 1149-1153, 1941.
11. SCHINZINGER: *München. med. Wchnschr.* 52: 1724-1725, 1905.
12. BEATSON, G. T.: *Lancet* 2: 104-107, 162-165, 1896.
13. FOVEAU DE COURMELLES, F. V.: *Compt. rend. Acad. d. sc., Paris* 145: 954, 1907.
14. WINTZ, H.: *Strahlentherapie* 24: 412-438, 1926-1927; *Radiology* 9: 285-303, 1927.
15. CABOT, A. T.: *Ann. Surg.* 24: 265-285, 1896.
16. WHITE, J. W.: *Ann. Surg.* 18: 152-188, 1893.

#### DISCUSSION

**William Thaw Clark** (Janesville, Wis.): I should like to ask Doctor Orndorff one question. Does he know of any series of cases of breast cancer that will show a difference in the results of oophorectomy and x-ray castration comparable with the effects of orchiectomy and roentgen castration in prostatic carcinoma?

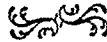
**Doctor Orndorff** (*closing*): Castration of the female for breast cancer by surgical methods is not at all new. Lawson Tate and Bland Sutton in England, Schinzinger in Germany, and others recommended it before the days when Halsted and Willy Meyer created the epic period of radical surgery for

cancer of the breast. In a review of the literature, however, it is found that a contributor would report a comparatively small series of cases in which oophorectomy had been performed, calling attention to its favorable influence on the tumor growth and general health; then for some reason the work would be discontinued, or at least no further record would appear. At a later date an entirely independent group of workers would report results of another series of cases. Furthermore, it is noteworthy that the percentage of good results would always remain about the same, *i. e.*, about 30 per cent.

In a study of reported cases of breast cancer treated by irradiation castration it seems fair to say that favorable reactions are claimed in about the same percentage of cases—approximately a third of those treated. In the light of more recent developments promising results are to be expected.

It has been quite well established clinically that with the occurrence of pregnancy cancer in the breast becomes more flagrantly malignant and the interruption of the pregnancy is amply justified. Furthermore, castration by surgery or irradiation is warranted. At this point I would like to emphasize, as I have endeavored to bring out in this presentation, the necessity of continuing a maintenance dose of irradiation for many months after a complete menolipsis has been established.

The advantage to be gained by castration of the male or female through surgery or by irradiation involves a consideration of many unanswered problems. Much can be said in support of either method but I am not familiar with the work of anyone who has made a comparative study of sufficiently sizable groups of cases to warrant definite conclusions. Personally, I am inclined to favor radiation castration in most cases.



# Use of the Basal Metabolic Rate in the Management of Radiotherapy for Leukemia<sup>1</sup>

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THIS STUDY OF the relationship between basal metabolism and leukemias was prompted by the following clinical observation:

In 1939 a patient previously treated for lymphatic leukemia presented himself for follow-up examination. He was at that time in excellent health, had a white count of 14,000 cells, a normal differential count, no lymphadenopathy, and no other clinical signs of leukemia. A routine determination of his basal metabolism, however, revealed a rate of +69 per cent. Since the patient felt perfectly well, the possibility of an error was considered, and the test was repeated one week later. The second determination showed +71 per cent and the patient was kept under close observation. Check-ups on the basal metabolic rate at weekly intervals showed no change, but four weeks after the first test, generalized lymphadenopathy developed, the patient grew continuously weaker, and within two more weeks the white count rose to 160,000 cells. Following x-ray therapy instituted at that time, the basal metabolic rate dropped within three weeks to +16 per cent, the white count decreased to 120,000 cells, but the lymphadenopathy showed little change. Therapy was then discontinued in order to observe the course of the disease. Within one month, the white count dropped to 18,000 cells and all clinical symptoms disappeared.

The importance of this observation seemed to lie in the fact that the pathological change in the basal metabolic rate manifested itself earlier than any other sign or symptom of the disease and was

influenced by therapy earlier than all other manifestations. It seemed worth while to investigate this problem more intensively.

The fact that the basal metabolic rate is elevated in a majority of patients suffering from leukemia is, of course, not a new observation. The phenomenon has been known since the last decade of the nineteenth century, when the early studies on metabolism were carried out (1, 2). In contrast to similar studies in thyrotoxicosis, however, this observation did not create any special interest among investigators until the year 1911. At that time, Grafe (3) reported his observation that leukemic blood cells have a high oxidative metabolism and that there seems to be a relationship between the degree of leukocytosis and the elevation of the basal metabolic rate in leukemia patients. Grafe's report inspired further investigations on the significance of the elevated basal metabolism in leukemias in three directions:

1. The nature of leukemic cells.
2. The possible relationship between leukemia and thyrotoxicosis.
3. The importance of determinations of the basal metabolic rate for following the clinical course of leukemias.

1. The morphological studies of leukemic blood cells did not facilitate a decision whether leukemias, which frequently are defined as tumors of the blood and the hematopoietic system, belong in the group of benign or malignant neoplasms. Grafe's investigations were the first clinical application of O. Warburg's newly developed method for physiological studies of cell metabolism. Warburg (4) had been able to show that under aerobic conditions normal cells have a rather high oxidative and

<sup>1</sup> From the Tumor Clinic (Erich M. Uhlmann, M.D., Director) of Michael Reese Hospital and the Department of Medicine (Prof. G. F. Dick, M.D., Chairman) of the University of Chicago. Presented before the Radiological Society of North America at the Twenty-eighth Annual Meeting, Chicago, Ill., Nov. 30-Dec. 4, 1942.

only a slight glycolytic metabolism, whereas malignant cells are characterized by a reversal of the respiration-glycolysis ratio, that is, they have a high aerobic glycolysis and a small oxygen consumption. This method became popular and was widely used for further investigation of the nature of leukemic blood cells. Barron and co-workers (5), Glover and co-workers (6), Schlossmann (7), Peschel (8), and Soffer and Wintrobe (9) reported results which did not always agree, but in 1939, Kempner (10) in carefully controlled experiments proved that the immature leukemic blood cells (myeloblasts and lymphoblasts) have a purely oxidative metabolism and do not form lactic acid under aerobic conditions; furthermore, that they "exhibit the characteristic metabolism of uninjured young cells and not that of cancer cells." The high basal metabolic rate of patients with leukemia must be considered the expression of the high oxygen requirement of the leukemic blood cells, and this fact would demonstrate that the leukemias constitute a special and singular type of neoplasm. No other neoplastic disease is to our knowledge characterized by an elevation in oxygen requirement.

2. The similarity of leukemias and thyrotoxicosis in their behavior toward oxygen uptake raises the question whether this represents only a symptomatic coincidence or whether other similarities may exist between these two diseases. Minot and Means (11) compared the increase in pulse rate in leukemia and thyrotoxicosis with the elevation of the basal metabolic rate and found that "the amount of pulse elevation for a given metabolic rate is the same in both diseases." Turner and co-workers (12), among others, studied the iodine level in the blood of leukemia patients and found that it is almost as high as in thyrotoxicosis. Friedgood (13) formulated the hypothesis that disturbances of the sympathetic nervous system together with generalized lymphoid hyperplasia might be the underlying factor in the pathogenesis of exophthalmic goiter

as well as in lymphatic leukemia. He therefore tried treatments with Lugol's solution in leukemia which, however, proved to be ineffective (14). On the basis of the same reasoning, Dameshek, Blumgart, and Berlin (15) performed a thyroidectomy on a patient with lymphatic leukemia in an attempt to influence the blood disease by lowering the basal metabolic rate. Although in this case the enlarged spleen decreased in size, no curative effect was obtained. It seems, therefore, that the high basal metabolic rate in leukemia and thyrotoxicosis, the increased pulse rate, and the elevated blood iodine level are symptoms produced by different mechanisms, though the final cause is unknown in both instances.

3. Grafe's original observation that the high basal metabolic rate in leukemia patients was related to the number of leukemic blood cells was confirmed by many investigators, especially by workers in this country. Boothby and Sandiford (16) found in 14 out of 16 patients with lymphatic and myeloid leukemia a basal metabolic rate above 20 per cent. In Gunderson's (17) series of 19 cases, the basal metabolic rate varied between +6 and +80 per cent, with a general tendency for the extreme metabolic rates to be associated with the highest leukocytosis. Similar findings were reported by McAlpin and Sanger (18) from their studies on a series of 16 patients during x-ray therapy. These authors also mention the fact that a rising metabolic rate sometimes foretold an approaching increase in the white blood cells. This observation is important, since it explains the discrepancy occasionally observed between the blood count and the basal metabolic rate, to which all authors in this field refer. It corresponds with the well known fact that the count of the white blood cells is not always an indication of the severity of the leukemic process, which depends more on the number of immature blood cells formed in the lymph nodes or bone marrow than on the number released into the blood stream.

The largest series of examinations has

been reported by Riddle and Sturgis (19), who carried out 267 basal metabolic rate determinations on 33 patients. Their findings, which are reprinted in Table I, demonstrate the general trend of parallelism between the basal metabolic rate and the blood count, as well as the individual variations and exceptions.

TABLE I: AVERAGE WHITE BLOOD CELL COUNT IN RELATION TO THE BASAL METABOLIC RATE IN CHRONIC MYELOGENOUS LEUKEMIA  
(Abstract of a table from Riddle and Sturgis, 19)

Number of Estimations	Average Basal Metabolic Rate	Average White Blood Count (thousands per c. mm.)
3	-14	13.3
48	- 5	35.3
63	+ 5	72.2
38	+15	118.1
34	+24	189.0
8	+35	220.1
7	+45	111.4
5	+63	290.8
3	+72	142.2
1	+81	342.0

A number of careful observations, in which the same patient was followed over a long period of time, with determinations of the basal metabolic rate through the various stages of the disease, have also been published (Murphy, Means, and Aub (20) and others). Most of these authors agree with the statements of Lennox and Means (21) and of Krantz and Riddle (22), that the basal metabolism is a truer indicator of the activity of the leukemic process than the count of the leukocytes. Minot and Isaacs (23), therefore, as early as 1924, recommended that "the treatment of leukemia should be guided and the prognosis formulated from the correlated information obtained from the patient's history and physical signs together with complete blood examinations and basal metabolic rate determinations. . . . The basal metabolic rate becomes considerably elevated when the disease process is distinctly active, and irradiation then is indicated despite blood findings which sometimes do not clearly reflect the patient's condition."

It would seem natural that with such extensive studies the clinical value of

determinations of the basal metabolic rate in patients with leukemia would be definitely established as a worth-while control in the treatment of leukemias. This, however, did not materialize, and the blood count remained in most instances the only laboratory index of the severity of the disease. The reasons for this development are manifold. On the one hand, technical inconveniences may have prevented the establishment of basal metabolic rate determinations as a routine method for leukemias in the same way as for thyrotoxicosis. On the other hand, the occasional discrepancies between basal metabolic rate and blood count may have influenced the decision not to rely on this method. Furthermore, it seems that the majority of clinicians, while considering the theoretical importance of this test, have failed to recognize its value for the actual clinical management of leukemias.

Minot and Isaac's conclusions, as well as McAlpin and Sanger's observation and our own findings, show that in many instances the basal metabolic rate is a more reliable test for the dynamic status of the leukemic disease than the blood count, since the basal metabolic rate is an expression of the actual hematopoiesis at the time, whereas the blood count may represent changes that have occurred earlier. The number of white cells in the blood, whether it is high or low, does not permit any conclusions as to the functional status of the disease. A low blood count may indicate a remission as the result of satisfactory treatment, but it may also be found if a new exacerbation is coming. The bone marrow or the spleen and the lymph nodes may be filled with new immature cells and yet the blood count may be low. On the other hand, a high white count may indicate great activity in the blood-forming organs and call for continuation of treatment. But the same high white count may persist for some time after effective treatment has paralyzed the hematopoiesis. In such instances, further treatments cause severe damage and precipitate aleukosis. In all



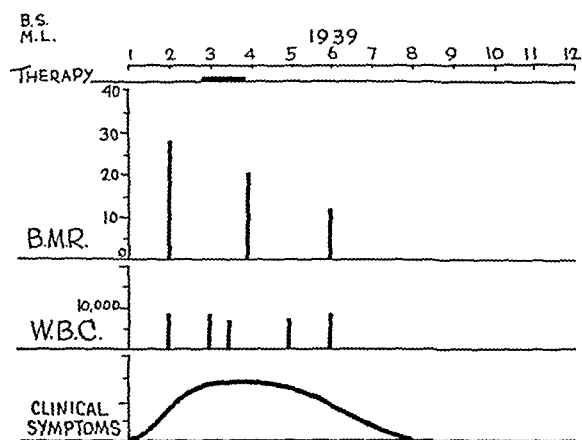


Chart 1. Myelogenous leukemia.

these instances, the basal metabolic rate may reveal the true functional state. A high basal metabolic rate, with or without a high white count, indicates that the disease is active and in most instances requires further therapy. Since the elevation of the basal metabolic rate often precedes the increase of the white blood cells, its determination will permit the institution of treatment much earlier than if the blood count is used as the only laboratory control. A low basal metabolic rate indicates that the disease is in remission, and that a high white count, if present at the same time, will decrease in due time without further treatment.

These statements are corroborated by our observations on patients suffering from lymphatic and myelogenous leukemias and in some instances of Hodgkin's disease where similar changes were found. This report includes continuous studies on 23 patients treated in the Tumor Clinic of Michael Reese Hospital: 12 with lymphatic leukemia, 10 with myelogenous leukemia, and one with Hodgkin's disease. In 7 of the 23 patients (3 lymphatic leukemias, 4 myelogenous leukemias), the basal metabolic rate at various times was within normal limits and did not rise above 10 per cent. In 5 others (3 lymphatic leukemias, 2 myelogenous leukemias), the basal metabolic rate was elevated in some instances above +50 per cent but, due to lack of co-operation on the part of the referring physicians or the patients, no

chronological studies could be performed and the records are not sufficiently complete to show the true relationship between the basal metabolic rate and the status of the disease. In the remaining 11 patients (6 lymphatic leukemias, 4 myelogenous leukemias, 1 Hodgkin's disease), observations were continued over a considerable length of time—in most instances for many years—and these findings allow definite conclusions.

Our observations in some of these patients are graphically recorded and several of the histories are given briefly. The graphic charts illustrating the case histories are drawn in an arbitrary manner showing on the abscissa the time expressed in months and on the ordinate the administration of treatments, the elevation of the basal metabolic rate, the white blood count, and the clinical symptoms.

Chart 1 is that of a patient with myelogenous leukemia whose white count during the time of observation never rose above 10,000 cells. In February 1939, he began to have clinical symptoms indicated by a swelling of the spleen, weakness, and typical blood findings. The symptoms became worse during the month of February and were intensive in the beginning of March 1939. The basal metabolic rate on Feb. 1 was +28 per cent and x-ray therapy to the abdomen was started on Feb. 24. Eleven treatments of 25 r each were administered, for a total of 275 r, the last treatment being given on March 29. The basal metabolic rate taken on March 21 was +21 per cent at a time when the clinical symptoms had shown no change. No further therapy was given. The patient began to feel better in April 1939. In May the basal metabolic rate was +15 per cent, the spleen was much smaller but still palpable, the patient's general condition was very good. At the end of July the spleen was within normal limits and the patient in excellent condition.

Chart 2 is of a patient with lymphatic leukemia and shows the follow-up over a period of four years. In January 1939, the basal metabolic rate was +23 per cent, but this was before we paid special attention to this phenomenon. The patient received x-ray therapy (19 treatments for a total of 475 r) for his clinical symptoms and felt well throughout the year. In March 1940, his basal metabolic rate was up to +40 per cent without any clinical symptoms or pathological findings in the blood. One month later, however, typical changes in the blood and lymphadenopathy occurred, with malaise and weakness. Therapy was instituted at that time.

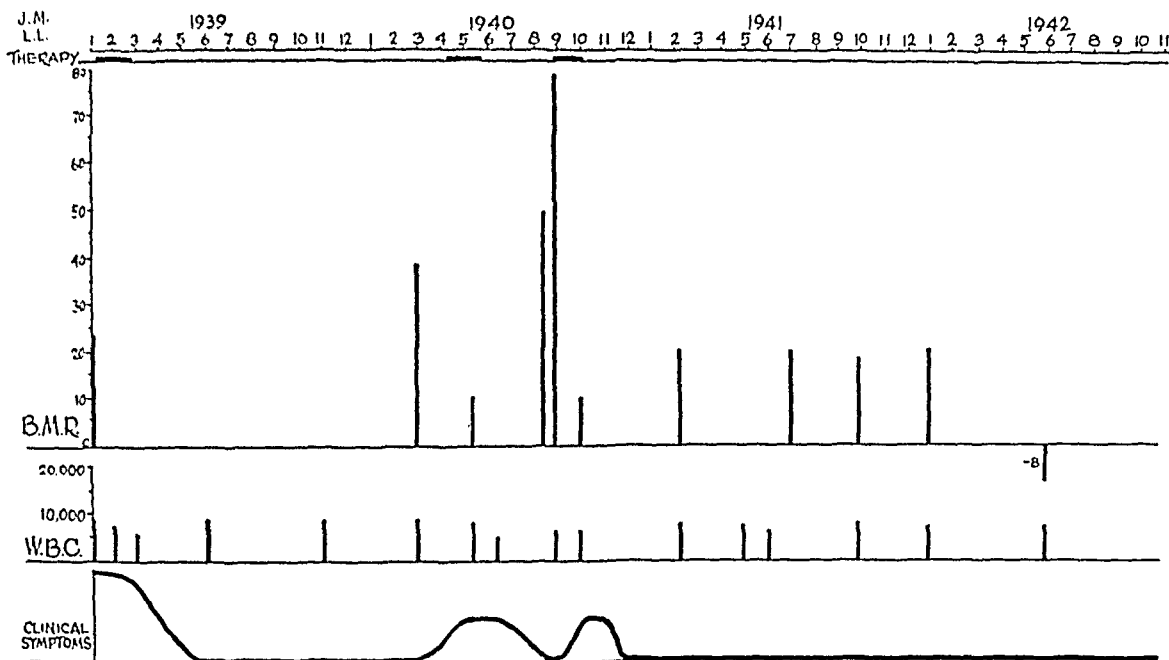


Chart 2. Lymphatic leukemia.

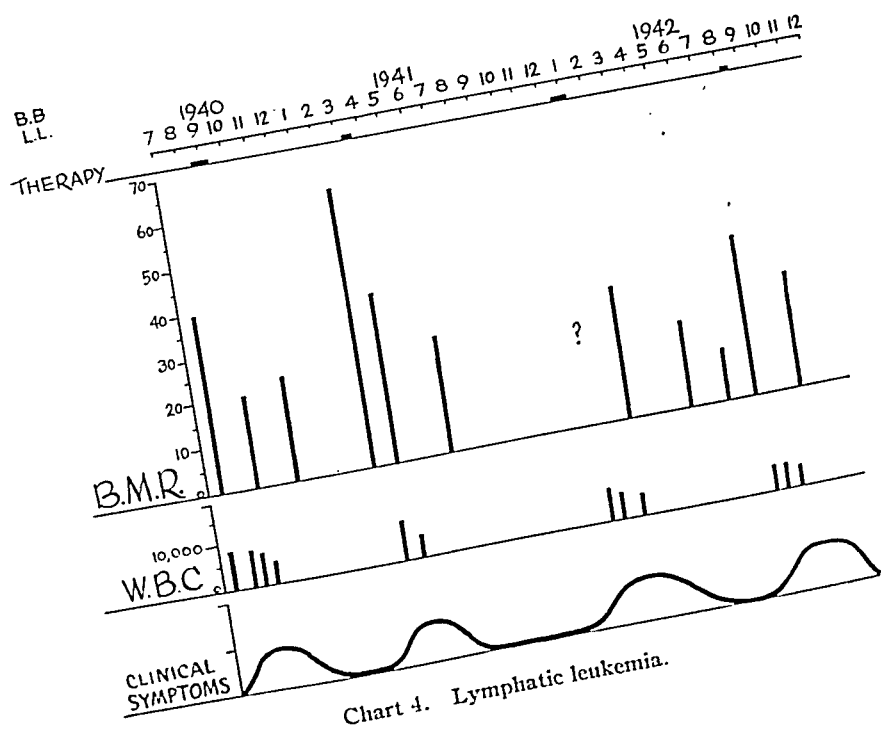
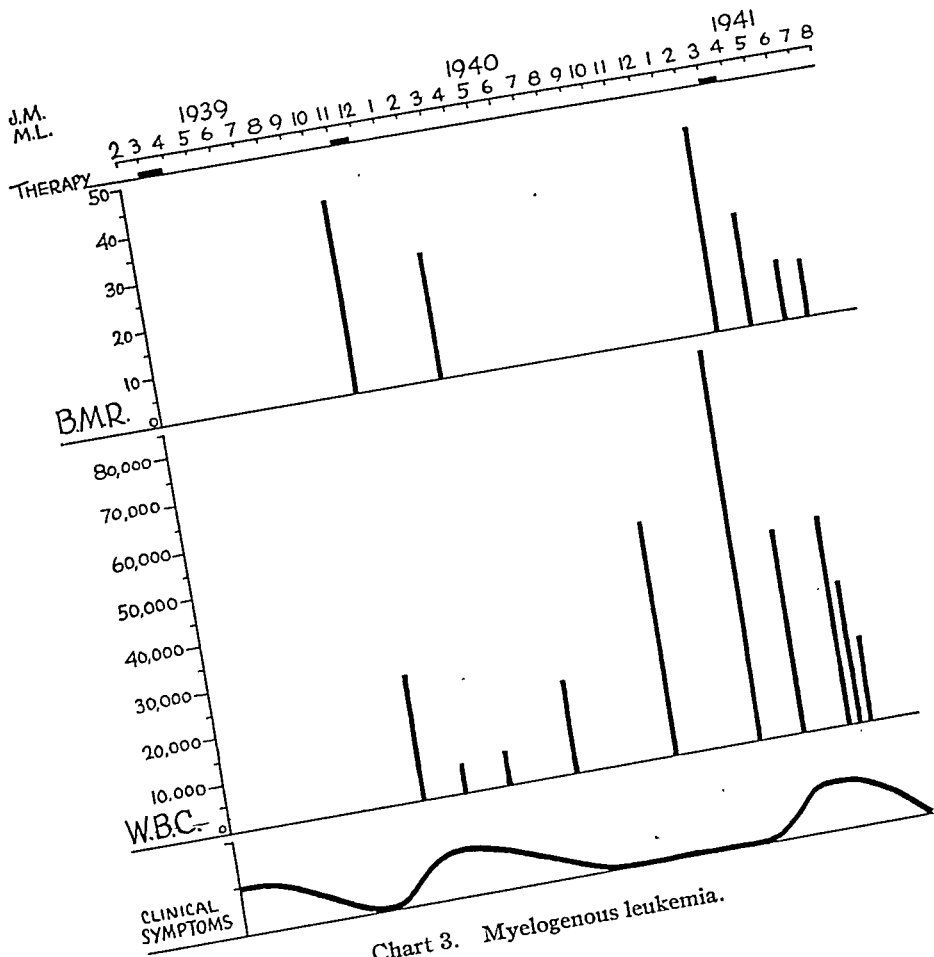
small amounts of x-rays given over the involved areas. The treatments were stopped when the basal metabolic rate showed a decrease to +9 per cent, in May, in spite of the fact that clinical symptoms were still present. Six weeks later the patient felt well without further treatments. In August 1940, while he continued to feel perfectly well, the basal metabolic rate was up to +48 per cent and two weeks later reached +78 per cent. Small lymph nodes were palpable, but the patient was comfortable. One week later x-ray therapy was started, because the swelling of the lymph nodes began to increase. After seven treatments, the basal metabolic rate dropped to +8 per cent. Again therapy was interrupted while the lymphadenopathy was still present and again after six weeks no symptoms were to be found. It is noticeable that, as in the first patient, the white count never rose above 10,000 cells. The patient has been followed and, until the beginning of 1942, his basal metabolic rate remained around +20 per cent. At one time it dropped to minus 8 per cent (May 1942), but clinical symptoms did not appear and no further therapy was given.

Chart 3 registers the history of a patient with myelogenous leukemia where the same principal relations between the clinical symptoms and the basal metabolic rate were observed. The case is reported to show the immediate influence of x-ray therapy on the basal metabolic rate, the short courses of treatment necessary, and the small amounts of radiation given (single doses of 25 r, totals of 200 r, 275 r, 315 r, respectively, in the three series of treatments). Furthermore, this patient had a marked increase in the white count which at times was as high as 80,000

cells, but the influence of therapy on the cell count manifested itself much more slowly and less reliably than on the basal metabolic rate.

Chart 4 shows the history of a patient with lymphatic leukemia observed over a period of two and one-half years. Again the count of the white cells gives no clue as to the severity of the disease, but the parallelism between the basal metabolic rate and clinical symptoms is obvious. During the time of observation, the patient had four remissions and a high basal metabolic rate preceded the clinical symptoms with almost surprising regularity. Treatments were given whenever the basal metabolic rate showed extreme values and consisted of single doses varying between 15 and 35 r. The total amounts of radiation given in the four series were 85 r, 85 r, 110 r and 85 r, certainly a remarkably low dosage. Therapy was stopped as soon as the basal metabolic rate started to decrease, and the clinical symptoms disappeared in due time. The basal metabolic rate taken in December 1941 is not recorded; it was originally given as +76 per cent but later it was reported that a technical error had been made in the determination, and it is therefore noted in the chart with a question mark.

Chart 5 covers a period of observation of four years in a patient with lymphatic leukemia who required treatment on three different occasions. In this case, the basal metabolic rate was at an average of +20 per cent even in the symptom-free intervals, but before each recurrence of clinical symptoms it rose above this average (up to +40 per cent in May 1940). The white count varied between 3,500 and 13,500, but was of relatively little significance as an index of the severity of the



patient's condition. Again the total amounts of x-rays given in a series were remarkably low, being between 250 and 275 r.

Chart 6 is that of a patient with lymphatic leukemia over a period of two and one-half years with findings similar to those in the patient represented by Chart 5. In this case, however, the number of white cells, while never being very high (maximum

three years and biopsies taken from the enlarged lymph nodes were very suggestive, though not conclusive, of this diagnosis. In December 1939, the patient was in extremely poor condition with generalized lymphadenopathy and malaise. The white blood count was normal and the differential blood picture showed no abnormalities. The basal metabolic rate at that time was +29 per cent.

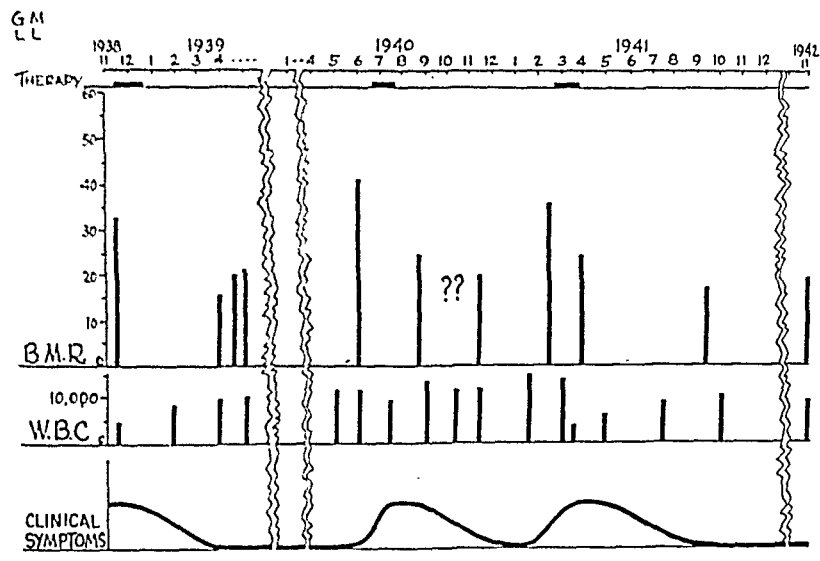


Chart 5. Lymphatic leukemia.

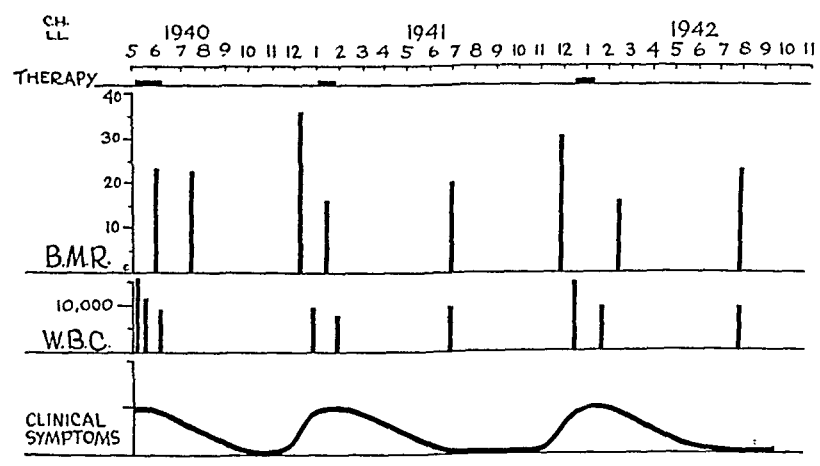


Chart 6. Lymphatic leukemia.

15,500) showed a definite response to therapy. The patient had been under care in the department since 1935 without control of the basal metabolic rate, and relatively large amounts of x-rays were given from 1935 to 1940. With the basal metabolic rate as a guide, a total of only 170 r and 245 r were given during the year 1941.

Chart 7 is of special interest, since the patient was suffering in all probability from Hodgkin's disease. He was under our observation for almost

Following x-ray therapy, the clinical symptoms gradually improved, and the basal metabolic rate dropped to +8 per cent in May 1940. One month later, lymphadenopathy again developed, and in spite of the fact that the basal metabolic rate was only +3 per cent, therapy was instituted, with the result that the clinical symptoms disappeared. At that time we had not had sufficient experience in judging the relation between basal metabolic rate and symptoms in the leukemias, and no ex-

perience whatever with the relationship in Hodgkin's disease. Following x-ray therapy, the basal metabolic rate dropped to  $-2$  per cent and remained at that level. In May 1941, the basal metabolic rate was  $-3$ , and with great hesitancy we administered x-ray therapy again, since the patient was suffering from general lymphadenopathy and weakness. The symptoms disappeared and the basal metabolic rate dropped to  $-7$  per cent. The patient then felt well for six months, when clinical symptoms recurred. The basal metabolic rate was now  $+2$  and we decided to refrain from any therapy so long as the symptoms were not so severe as to require hospitalization. After six weeks the symptoms subsided spontaneously without treatment, and the patient was able to resume his activities as a traveling salesman. In July 1942, the basal metabolic rate began to rise slowly from  $+11$  per cent to  $+16$

the regular performance of this laboratory test will be of significance in evaluating the course of the disease. In the majority of patients under our observation, the basal metabolic rate was the first indication of an approaching exacerbation of the symptoms, preceding the clinical signs, and in most instances changes in the blood, often by weeks. On the other hand, when therapy was effective in the disease, the basal metabolic rate was the first symptom to show this influence clearly. It could, therefore, be used to indicate the time for initiating and terminating treatments.

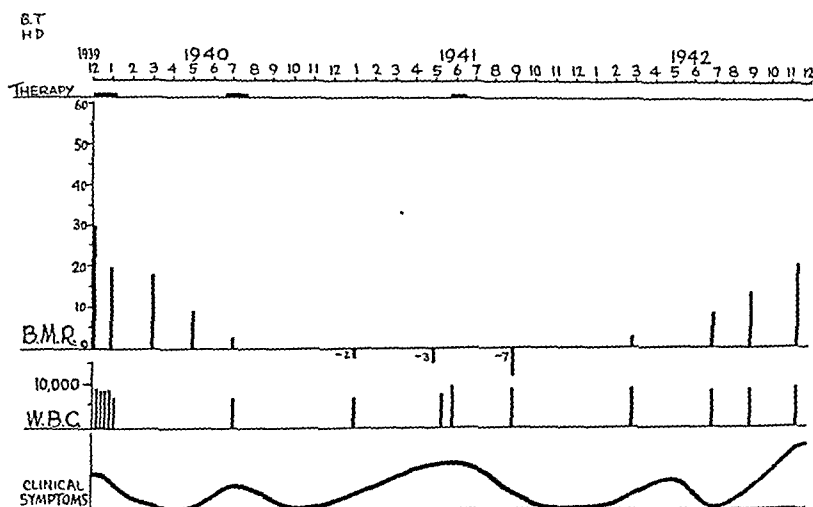


Chart 7. Probable Hodgkin's disease.

per cent to  $+22$  per cent in November, and the patient again had symptoms. At that time he had left Chicago and, in spite of our urgent advice, did not return to the hospital or undergo medical care elsewhere. He was finally admitted to another hospital, where he died in December 1942. We feel it worth while to mention the case here because there seems to be a relation between the basal metabolic rate and the clinical symptoms in Hodgkin's disease, even if it is less significant and reliable than in the leukemias.

The conclusions to be drawn from these examples, and from observations in many more instances with shorter periods of follow-up, are suggestive. In patients suffering from lymphatic or myelogenous leukemia, and, as we found, even in patients with Hodgkin's disease, where the basal metabolic rate is abnormally high,

It may be recalled that up to twenty years ago it was thought desirable, when x-rays were used in the therapy of the leukemias to continue treatments until the white blood count declined to normal. In many patients this proved to be fatal, since a leukopenia developed from which they did not recover. For the past two decades, the general condition of the patient receiving x-ray therapy has been much more closely watched, and treatments have generally been interrupted when an improvement in the subjective symptoms indicated a change, even though the white blood count had not decreased to normal figures.

Observation of the basal metabolic rate in those patients in whom it is elevated

(and they are in the majority) is a laboratory test which gives better and more definite indications for the interruption of the treatments than other tests or symptoms. We have been able to produce excellent clinical results by administering only a fraction of the doses previously used and believe that this is of advantage for several reasons. First, the small amount of radiation which is sufficient to clear up the symptoms does not generally produce any ill effects. Secondly, if the dose of x-rays is limited, the patient will become resistant to irradiation at a much later date than with the large amounts hitherto applied. This latter fact—if proved over a period of years, as our observations seem to indicate—would very probably increase the life expectancy of patients suffering from leukemia to a considerable degree. Since x-rays are only a symptomatic remedy for the disease and as yet no causative therapy is known, the most effective and the most economic application of radiation therapy is certainly indicated, and the determination of the basal metabolic rate seems to facilitate this task.

While it is not the purpose of this paper to enlarge on technical details with regard to the application of x-ray therapy in leukemias, it may be mentioned that in most instances, unless circumscribed severe lymphadenopathy required local treatment, x-rays were applied at a distance of 100 cm. over the trunk, with single doses of 15 to 35 r. The number of treatments given varied between 2 and 13, and the patients tolerated these treatments extremely well.

#### SUMMARY

Clinical observations and a review of the literature show the close relationship of the basal metabolic rate and the severity of the clinical symptoms in patients suffering from leukemia. The basal metabolic rate is elevated in a majority of these patients when an exacerbation of the disease is approaching and decreases as soon as therapy is effective. This is usually long before any other manifestations (white

blood count, enlargement of spleen, lymphadenopathy, subjective symptoms) show response to therapy. It is recommended, therefore, that the evaluation of the basal metabolic rate be used in determining the proper time for initiating and terminating therapy. It will be found that, by following these suggestions, very small amounts of x-rays are sufficient to control the disease. This in turn permits the patients to tolerate the treatments and may even substantially increase the life expectancy by deferring the time when resistance to therapy develops.

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#### BIBLIOGRAPHY

1. MAGNUS-LEVY, A.: in von Noorden's Handbuch.
2. DuBois, E. F.: Basal Metabolism in Health and Disease. Philadelphia, Lea & Febiger, 3d ed., 1936.
3. GRAFE, E.: Deutsches Arch. f. klin. Med. 102: 406, 1911.
4. WARBURG, O.: Ueber den Stoffwechsel der Tumoren. Berlin, Julius Springer, 1926.
5. BARRON, E. S. G., AND HARROP, G. A., Jr.: J. Biol. Chem. 84: 89-100, October 1929.
6. GLOVER, E. C., DALAND, G. A., AND SCHMITZ, H. L.: Arch. Int. Med. 46: 46-66, July 1930.
7. SCHLOSSMANN, H.: Biochem. Ztschr. 219: 463-467, 1930.
8. PESCHEL, E.: Klin. Wchnschr. 9: 1061-1062, June 7, 1930.
9. SOFFER, L. J., AND WINTROBE, M. M.: J. Clin. Investigation 11: 661-676, July 1932.
10. KEMPNER, W.: J. Clin. Investigation 18: 291-300, May 1939.
11. MINOT, G. R., AND MEANS, J. H.: Arch. Int. Med. 33: 576-580, May 1924.
12. TURNER, K. B., McALPIN, K. R., AND DELAMATER, A.: Proc. Soc. Exper. Biol. & Med. 39: 55-56, October 1938.
13. FRIEDGOOD, H. B.: Am. J. M. Sc. 183: 515-529, April 1932.
14. FRIEDGOOD, H. B.: Am. J. M. Sc.: 183: 841-849, June 1932.
15. DAMESHEK, W., BERLIN, D. D., AND BLUMGART, H. L.: New England J. Med. 210: 723-730, April 5, 1934.
16. BOOTHBY, W. M., AND SANDIFORD, I.: J. Biol. Chem. 54: 783-803, December 1922.
17. GUNDERSON, ARTHUR H.: Boston M. & S. J. 185: 785-787, 1921.
18. McALPIN, K. R., AND SANGER, B. J.: Am. J. M. Sc. 167: 29-38, January 1924.
19. RIDDLE, M. C., AND STURGIS, C. C.: Arch. Int. Med. 39: 255-274, February 1927.
20. MURPHY, JAMES B., MEANS, J. H., AND AUB, J. C.: Arch. Int. Med. 19: 890-907, 1917.
21. LENNOX, W. G., AND MEANS, J. H.: Arch. Int. Med. 32: 705-708, November 1923.
22. KRANTZ, C. J., AND RIDDLE, M. C.: Am. J. M. Sc. 175: 229-242, February 1928.
23. MINOT, G. R., AND ISAACS, R.: Boston M. & S. J. 191: 1-9, July 3, 1924.

## DISCUSSION

Raphael Isaacs, M.D. (Chicago, Ill.): Doctor Uhlmann has brought out a very important point in connection with the treatment of leukemia. When we think of leukemia, we naturally think of something wrong with the blood. The name itself—white blood—shows that attention is focused on the blood. As time has gone on, however, we are changing that attitude and are focusing our attention on the place where the blood cells are made. There may be some fundamental disease of the bone marrow or of the spleen or the lymph nodes and the pathological process may be limited to those organs, while the blood itself shows no significant change. The condition of the blood in such cases may therefore be misleading.

When a person has leukemia, the bone marrow, for example, grows at an extremely rapid rate, filling every possible space in the bones, increasing in amount from two to five times. When bone marrow cells grow very rapidly, they absorb oxygen and as an increase in oxygen utilization occurs, the patient uses more oxygen. The amount of oxygen in the blood stream is roughly proportional to the amount taken into the lungs, and the amount taken into the lungs is roughly proportional to the amount used in breathing, which, of course, is the clinical basal metabolic rate.

The basal metabolic rate, therefore, is indicative of the condition of the patient; it is more expressive of the extent of the disease than the actual blood count, since the latter is an accident; that is, some cells from the leukemic tissue may accidentally get into the blood stream and produce an abnormal count but, on the other hand, this "accident" may not happen.

After x-ray therapy, as is shown in the charts, the basal metabolic rate may rise from one to three days before it starts to fall. This is interesting, since, if you study the bone marrow at that time,

you will find that the actual number of cells may be increased—and sometimes the cells in the blood stream, also—at least during the first twenty-four hours. Then, as the cells mature, they die of old age or of necrosis, whichever you wish, and their number decreases. Thus, the increased number of cells after x-ray therapy is also related to the increase in basal metabolic rate in the first twenty-four or forty-eight hours.

It is not always necessary to make a basal metabolism test. This may not be feasible or it may not be within the patient's means. There are several clinical features by which one can judge whether or not the rate is elevated. For example, loss of weight in spite of a fair appetite, intolerance to heat, abundant perspiration, especially night sweats, irritability, restlessness, and a "jittery" feeling.

The word "jittery" seems to apply particularly well in these cases. The patient with hyperthyroidism is nervous; all his muscles are tense and he is having tremors. Here, on the other hand, he merely feels jittery, for the reason that one of his organs is working four or five times as fast as the rest of his body, which is trying to relax. The pulse rate is more rapid than normal. There are, to be sure, other features which may cause a rapid pulse rate, but as a rule the elevated basal metabolic rate is fairly proportional to the increase in the pulse rate. One author says that 7 per cent increase in pulse rate corresponds roughly to 10 per cent rise in the basal metabolic rate.

Still another point to be considered is the feeling of weakness. The first clinical symptom that a patient notices when he has leukemia is a sense of weakness, ease of fatigue, and we wonder why this appears so much earlier than a change in the white blood count. I think Doctor Uhlmann has given the answer to that question, for while the blood cell count may not rise until some time later, the increase in the basal metabolic rate accompanies the change in the bone marrow.

# Inhalation Pneumonia from Nitric Fumes<sup>1</sup>

MORTIMER R. CAMIEL, M.D. and HENRY S. BERKAN, M.D.

Brooklyn, N. Y.

ACUTE INHALATION pneumonias caused by noxious fumes are increasing in frequency. With the complexity and volume of wartime industry, and indeed with wartime hazards themselves, the roentgen appearance of such pulmonary accidents assumes a special significance. The roentgen literature, however, contains few recent accounts of the findings.

Many industrial gases are potentially dangerous. Of particular interest are the acute pulmonary changes resulting from the inhalation of nitric fumes, especially those produced by welding. While there are numerous gases and fumes arising in the welding arc or flame, most of the ill effects of inhalation have been ascribed wholly or in part to the oxides of nitrogen (1, 2, 4, 7, 8, 9, 10, 11, 12, 13, 14, 17, 19, 21, 22, 23, 24, 25).

Nitric fumes occur extensively in industry (9, 15), but unless the fumes are generated in confined, unventilated places, the concentration is not of sufficient degree to be toxic (2). From time to time, however, accidents do occur and there then results an acute pulmonary picture with severe reactive changes. The patient, if removed from the noxious environment, may recover following a pulmonary episode of varying severity, or the response may be an overwhelming edema of the lung and death.

We have studied the chest roentgenograms of two patients who became acutely ill following the inhalation of nitric fumes. Both recovered. In the first instance the fumes were generated by the open-vat mixing of nitric acid with hydrochloric acid. In the second case they were formed by acetylene welding in the hold of a ship. Garland (5) recently suggested the term

"nitric fume pneumonia" or "pneumonia complicating nitric fume poisoning" to designate this condition. Although both of our cases were associated with the inhalation of nitric fumes and the clinical syndromes were similar, we are reluctant to adopt this specific terminology, since we believe that many inhaled chemical irritants may cause a similar response. Doub (3) reports that nitric fumes and the war gases, phosgene, diphosgene, chlorine, and chloropicrin, produce similar pulmonary exudative changes, with a similar clinical course. With some variations among the different gases, the bronchopulmonary response may range from irritation to rapid death following pulmonary edema (13). We therefore prefer the more inclusive term, "inhalation pneumonia." This discussion will, however, be limited to nitric fumes, since they appear to have been the offending factor in our cases.

Nitric fumes occur in those industries where nitric acid is used (15), as in the production of sulfuric, picric, and chromic acids; in the manufacture of toluene, metallic nitrates, methyl nitrate, celluloid, nitrocellulose (gunpowder), collodion, Prussian red, English red, etc.; in metal testing, the manufacture of jewelry and of artificial pearls, engraving, the manufacture of artificial leather, and the production of explosives (nitroglycerine, dynamite, etc.). The fumes arise, also, in connection with the industrial use of nitric acid compounds, such as nitrates, nitrocellulose, nitrobenzene, and aniline, and in the commercial preparation of nitric oxide by the Haber method. To this list Johnstone (9) adds tunnel working, mining, carbon arc-booth operating (moving pictures), and all types of welding as sources of nitric fumes.

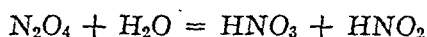
It is believed by some (2) that the nitrous gases make the body more sensitive to carbon monoxide and that a combination of

<sup>1</sup> From the Department of Roentgenology, Kings County Hospital, Brooklyn, N. Y., Richard A. Rendich, M.D., Director. Accepted for publication in July 1943.

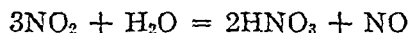


factors is responsible for some of the reported deaths.

Nitric fumes consist of five oxides of nitrogen (2): nitrous oxide ( $\text{N}_2\text{O}$ ), nitrogen trioxide ( $\text{N}_2\text{O}_3$ ), nitrogen pentoxide ( $\text{N}_2\text{O}_5$ ), nitric oxide ( $\text{NO}$ ), and nitrogen peroxide or nitrogen dioxide ( $\text{NO}_2$  or  $\text{N}_2\text{O}_4$ ). The dioxides are said to be the most insidious and toxic of the group. They are the brown fumes seen in reactions of nitric acid. In whatever molecular form the dioxide is inhaled (15), it is altered to that corresponding to body temperature. At  $40^\circ\text{C}$ . approximately 30 per cent is in the form of  $\text{NO}_2$  and 70 per cent is in the form of  $\text{N}_2\text{O}_4$ . It is in this proportion that the gases act on the respiratory tract.  $\text{N}_2\text{O}_4$  reacts with the water of the respiratory membrane to produce nitric acid and nitrous acid:



$\text{NO}_2$  reacts with the air and moisture in the respiratory tree to produce nitric acid and nitric oxide:



Pulmonary accidents due to nitric fumes must certainly date back to antiquity. The electric arc was discovered in 1812 by Davey. According to Britton and Walsh (2), who give an extensive bibliography on the subject of health hazards of welding, Cavendish shortly afterward discovered that nitrogen oxide was formed in the electric arc. La Towsky *et al.* (11) refer to the first autopsy in a case of nitrogen fume inhalation, performed by Cherrier in 1823. From time to time since then, occasional references to the subject have appeared. More recently, the nitrocellulose film fire in Cleveland (16) with its disastrous pulmonary effects due to inhalation led to renewed interest in the problem. Of late, especially in the foreign literature, there have been scattered reports of serious pulmonary accidents or deaths ascribed to nitric fumes produced by welding in poorly ventilated places (1, 2, 7, 8, 9, 10, 12, 14, 17, 18, 25) or in other industrial tasks, such as working with acids (3) or dynamiting (6).

The pathological changes in the lungs may be expected to vary with the intensity of the exposure. With a mild inhalation there may be no reactive changes or only a slight inflammatory response in the mucosa of the tracheobronchial tree. With inhalation of larger amounts the inflammatory changes extend farther downward to include the minutest bronchioles, and secretion into the lumina and vascular engorgement are more prominent. With still greater severity, acute hyperemia and edema around the bronchioles result in pulmonary infiltrations, giving a miliary or nodular appearance. A sterile bronchopneumonia follows. Up to this point the process is reversible and the patient may recover, with no residual changes. More advanced or severe damage may terminate in death due to injury to the respiratory epithelium and alveolar and capillary walls, resulting in marked extravasation of fluid and pulmonary edema. Failure of the right heart may be present (14). Nichols (16) states that pulmonary edema may be either slight or so extensive that the patient drowns in his own secretions. If death occurs after an interval, miliary fibrous nodules may be found at the terminal bronchioles (16, 20). Congestion, bronchopneumonia, purulent bronchitis, and pleural effusions all play a part (16). With severe exposures, methemoglobinemia may be a prominent cause of rapid asphyxia (11). Lung changes due to chronic inhalation have been described among welders. They resemble a nodular silicosis and are said to be due to the deposition of iron oxide, a component of the welding fumes, and not to the nitric components. In a limited group of cases, the exposure is insufficient to cause a rapid termination, but the injured respiratory tract constitutes a fertile field for bacterial invasion so that a delayed pneumonitis or a bronchopneumonia may supervene (11).

The signs and symptoms of nitric fume inhalation are usually delayed (9). There may be a latent period after exposure of from several hours to twenty-four to thirty hours. For that reason, there is no

doubt that many cases of nitric oxide fume inhalation in industry go uncompensated, since the relation between cause and effect is not apparent. The fumes are more irritating to the lung than to the nasopharynx, so that they may be inhaled for a long time without the patient becoming aware of it. He may see the fumes, but is not warned by any distressing symptoms such as the immediate dramatic effects upon the upper respiratory passages produced, for example, by chlorine or ammonia.

The initial symptoms are headache, dizziness, palpitation, a sensation of pressure upon the anterior chest wall, and a dry cough. These may disappear completely if the patient is exposed promptly enough to fresh air. They are followed shortly by a chill, elevation of temperature, severe respiratory distress, and cyanosis. Where the exposure has been limited, the picture may resemble that of an acute bronchitis or a severe attack of asthma, with physical signs of coarse, moist râles and rhonchi throughout the lungs. Such patients usually recover and there is a gradual subsidence of respiratory symptoms over a period of several days to one or two weeks. Their acute illness or convalescence may be complicated by lobar or lobular pneumonia with all its attending manifestations. In that event, recovery may occur after weeks of remissions.

Where the concentration of gas has been higher or exposure more prolonged, death usually takes place within forty-eight hours. The irritating effect upon the respiratory mucous membrane is so overwhelming that the patient literally drowns in his own edema fluid. In such rapidly fatal cases the pathological findings will be limited to the lungs. Where, less commonly, death is delayed for one or two weeks, right heart failure, pleural effusions, pulmonary congestion and infection, anemia, and focal hemorrhagic lesions in various organs, all play a role. It should be re-emphasized, however, that the initial and the fundamental effects of inhalation stem from trauma to the respiratory mucous membrane.

Although there is no definite proof of chronic pulmonary disease occurring as a direct effect of nitrous fumes, certain symptoms, as headache, sleeplessness, anorexia, weight loss, and a dry cough, have been attributed to prolonged low-grade exposure to these fumes (9).

The roentgen features in cases of acute nitric fume inhalation are of particular interest. The x-ray appearance must be interpreted in the light of our knowledge of the type of irritant and the pathological changes that result. As Sante has pointed out, the inhaled fumes, carried to the minutest bronchioles, cause an irritative bronchiolitis which is manifested in the roentgenogram as an irregular soft mottling throughout the lungs (20). These submiliary, pseudonodular patches of increased density follow the course of the bronchiolar tree and extend out to the very periphery of the lung. They have a more or less even distribution and show no hilar or central preponderance as would the lesions of cardiac decompensation or pulmonary azotemia, which they resemble. Although initially they tend to be discrete and pseudonodular, they subsequently merge and become confluent as edema and minute areas of atelectasis are superimposed on the initial changes caused by irritative bronchiolitis and hyperemia. Later, areas resembling confluent patches of bacterial invasion may appear and, if graphic picture will be further altered.

With a rapid fatality, the lungs are bathed in edema fluid. In those patients who recover, however, the most striking roentgen feature is the widespread rapidity of resolution of the widespread radiative infiltrations. Serial roentgenograms taken only a few hours apart will demonstrate perceptible clearing. As the acute edema subsides, the pseudonodular infiltrations disappear, leaving in their place only exaggerated lung markings caused by the composite shadow of engorged blood vessels and corroded bronchi and bronchioles. Within a few days, even these latter findings are no longer seen. In favorable

cases, only four to ten days elapse from the time of exposure until complete disappearance of roentgenographic evidence of inflammatory pulmonary response. Unless infection supervenes, there are no residual manifestations (3, 6, 7, 18). Nichols, in studying the films of patients exposed to burning nitrocellulose fumes, found submiliary nodules in the lungs of those who made a prolonged recovery. These nodules, however, faded after two weeks and were attributed to a transient interstitial fibrosis replacing the acute exudative response.

If it is understood that the action of the nitric fumes is upon the superficial lining of the tracheobronchial tree, then the explanation for the reversible character of the pathological changes and the resulting roentgenographic lesions is clear. If exposure had been so severe that necrosis of the lining membranes had occurred, with the resulting formation of granulation tissue, we might expect residual findings. Such overwhelming exposure is, however, more apt to result in rapid death, either from asphyxia or an irresistible pulmonary edema.

#### CASE REPORTS

CASE 1: A. M., white male aged 46, entered Kings County Hospital on March 2, 1941, because of severe respiratory distress of one day's duration. He had previously been in good health, but had had a mild cough for several weeks. At the time of admission he was engaged as an odd-job man by a metal-cleaning firm. On the day of admission, he had spent approximately half an hour mixing nitric acid with hydrochloric acid. He wore no mask. Although he was conscious of the fumes, they caused him no distress. About one hour after he had inhaled the fumes, he experienced paroxysms of cough and pain over the upper chest anteriorly. Very shortly thereafter he felt chilly and ill.

The patient was first seen approximately twelve hours after the inhalation. He was well oriented but was acutely ill, with severe respiratory distress, a dry cough, and moderate cyanosis. The temperature was 103.2°, pulse rate 120, respiratory rate 40 per minute. The blood pressure was 105 systolic and 70 diastolic. The chest expanded equally throughout. The percussion note was resonant bilaterally. The auscultation was clear throughout both lung fields. Moist râles were heard throughout both lung fields. The heart was not enlarged. Its sounds were regular and of good quality. The remainder of the physical examination was negative.

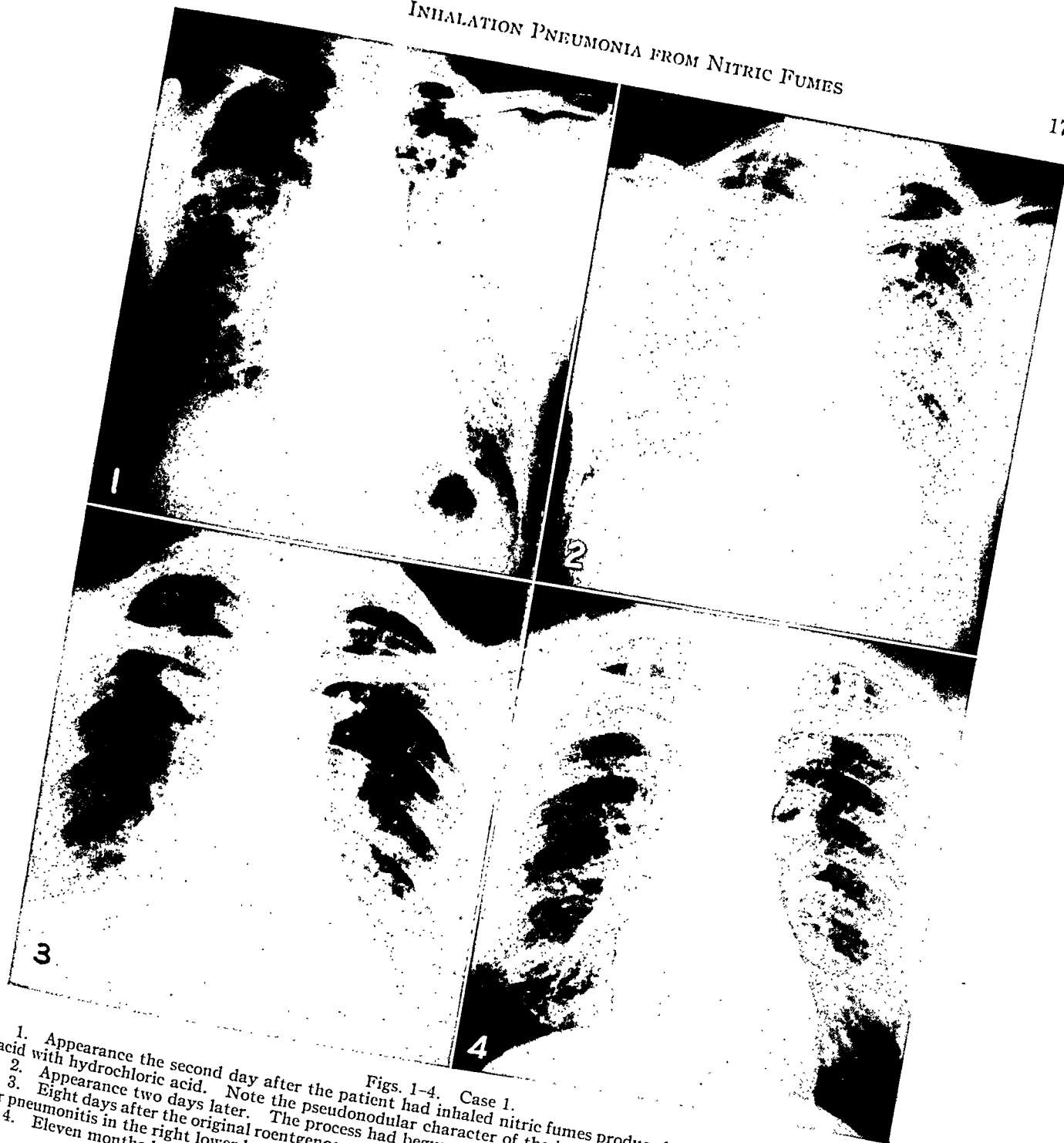
The blood Wassermann reaction was negative.

Three blood cultures were sterile. The initial blood count (March 3) revealed a hemoglobin of 14.0 gmi., 4,200,000 red cells, and 18,500 white cells with 87 per cent polymorphonuclear leukocytes. A second blood count, eight days later, gave a hemoglobin of 12.0 gm. with 6,500 white cells, of which 70 per cent were polymorphonuclears. The initial blood chemical studies revealed a urea determination of 80.0 mg. per 100 c.c. of blood and a creatinine determination of 2.3 mg. per 100 c.c. of blood. Two days later (March 5) the urea was 45.0 mg., the creatinine 1.8 mg. On March 11 the blood urea had returned to normal, 22.0 mg. per 100 c.c. of blood. On three occasions urine studies were negative. The specific gravity of the urine varied between 1.025 and 1.020.

On admission, oxygen was administered and the patient also received sulfapyridine therapy. At no time was there sputum to type. The cyanosis and dyspnea were slightly diminished the next day, but at that time the patient was drowsy and poorly oriented, though he responded to questions. Within four days of admission the symptoms had almost completely regressed and the temperature had returned to normal. On two subsequent occasions a rise of temperature to 103° occurred, but these elevations of temperature were not associated with a recurrence of the initial symptoms. By the eighth hospital day, the patient was sufficiently recovered to sit up in bed. He was discharged after seventeen days in the hospital. He refused to return to his old occupation.

The initial roentgenogram (Fig. 1), taken the day after admission, was reported as showing "evidence of confluent areas of bronchopneumonic consolidation involving the major portions of both lung fields. The configuration of many of the areas of infiltration is somewhat nodular and dense, suggestive of an underlying occupational disease (pneumoconiosis)." Interval studies were advised to differentiate between a simple bronchopneumonic process and an inflammatory one superimposed on an underlying silicosis. The inhalation aspect of the roentgenogram with its attending bronchiolitis was not appreciated. Two days later, a second roentgenogram (Fig. 2) revealed a "marked degree of resolution of the formerly described areas of consolidation throughout both lung fields. Residual areas of interstitial change persist at the site of previous involvement. Findings, therefore, previously described are those of an acute inflammatory process." A third roentgenogram, six days later (Fig. 3), revealed "complete resolution of diffuse infiltration, except for a plate-like area of atelectasis or pneumonitis at the right base. There was residual accentuation of pulmonary trunk markings, particularly in the hilar regions." No further roentgenograms were taken before the patient's discharge eight days later.

Almost a year afterward, when the roentgenograms of Case 2 were studied, their marked similarity with those of this case and the history of



Figs. 1-4. Case 1.

1. Appearance the second day after the patient had inhaled nitric fumes produced during the mixing of nitric acid with hydrochloric acid. Note the pseudonodular character of the infiltrations.
2. Appearance two days later. The process had begun to subside.
3. Eight days after the original roentgenogram, the lungs had cleared with the exception of an area of atelectasis or pneumonitis in the right lower lung field. This was a complication of the original process which had cleared.
4. Eleven months later no residual changes could be detected.

exposure to fumes in both instances led to a restudy of the films. The patient was located and a follow-up roentgenogram was obtained. During the interval he had been well and free of all respiratory complaints. Figure 4 is the roentgenogram taken on Feb. 14, 1942, eleven months after the original exposure. There are no residual parenchymal infiltrations.

CASE 2: J. M., white male aged 49, a coppersmith and sheet metal worker by trade, entered Kings County Hospital on Jan. 10, 1942, complaining of headache and dizziness of one day's duration. He stated that he had always been in good health. On Jan. 9 the patient reported to work at 7 A.M. at a shipyard. His job that day was to assist a welder in the brazing of pipes by means of an acetylene



Figs. 5-8. Case 2.

5. Appearance the second day after the patient had inhaled nitric fumes produced during acetylene welding.
6. Appearance two days later. The process had begun to subside.
7. Four days after the original roentgenogram, the lungs had almost completely cleared with the exception of a few faint infiltrations, the size of a match head, in the central lung fields.
8. One month later no residual changes could be detected. The linear shadow in the right lung field is an artefact.

torch. They were working in a ship's hold, "three decks down." In the process of welding, fumes were liberated which could be seen and smelled. The welder wore a gas mask, but his assistant, the patient, did not have one. From 7 to 11:30 A.M. he was

exposed to the fumes. He continued to work until P.M., when, because of his dizziness, he went to the dispensary. There, after being given a gas to inhale, he felt slightly better. He had been coughing on and off since morning. The same night he was so dizzy

that he called an ambulance and was admitted at 2 A.M., Jan. 10. It is interesting to note that he stated that the welder whom he assisted also felt "sick," despite the mask.

The patient was a husky, middle-aged man. He was moderately dyspneic; his respirations were shallow. He coughed frequently but produced no sputum. His temperature on admission was  $100.2^{\circ}$ , pulse 100 per minute, respiratory rate 35 per minute. His blood pressure was 135 systolic, 70 diastolic. There was a diffuse erythema over his face. The chest expanded equally bilaterally. There was no impairment of percussion. Many moist râles were heard over the lower halves of the lung fields. The heart was not enlarged and auscultation revealed a regular rhythm without murmurs. The remainder of the physical examination was negative.

The blood Wassermann reaction was negative. Further laboratory studies were not available. The patient was never very uncomfortable. On the morning after admission, his dizziness and headache had disappeared. After three days, his dyspnea and non-productive cough were no longer present. His temperature varied between  $99$  and  $100.6^{\circ}$ . On the fourth day, Jan. 14, he stated that he felt "fine" and was sent home.

The initial roentgenogram (Fig. 5) was taken on the day of admission, the second day of illness. It was reported as showing "a generalized submiliary pseudonodular infiltration throughout both lungs. The nodules vary from match-head to pea size. The changes are compatible with an acute exudative reaction with severe bronchiolitis and submiliary bronchopneumonia following the inhalation of an irritant." Two days later, it was reported (Fig. 6) that "the formerly noted irregularly sized areas of nodular infiltration have regressed to approximately half their former size." In two days, the picture had changed from one of widespread confluent infiltrations indicative of bronchiolitis and surrounding edema to one of only faintly outlined pseudonodular patches surrounded by considerably re-aerated lung. On the day of discharge a third roentgenogram (Fig. 7) revealed an almost complete subsidence of the findings. A few residual infiltrations the size of a match head were present in the right central lung field.

A follow-up study on Feb. 9, 1942 (Fig. 8), one month after the exposure, during which time there had been no recurrence of symptoms, revealed complete absence of residual parenchymal changes.

#### DISCUSSION

In each of the cases described above, the patient became acutely ill following the inhalation of nitric fumes. Although the fumes were generated under different circumstances, the effects on the lungs appeared to be identical. In each instance the chest roentgenogram was character-

ized by an unusually widespread pseudo-nodular infiltration completely filling both lung fields. During the most acute stage the infiltrations varied in size from that of a match head to a pea. In many areas these were confluent, forming larger patches; however, the nodular appearance was easily recognized (Figs. 1 and 5). It appeared as if the irritant had been inhaled to the smallest bronchioles, with local response to the resultant chemical inflammation. Acute hyperemia and edema around the bronchioles resulted in the pulmonary infiltrations giving the nodular appearance. Fortunately the noxious agent had been inhaled in amounts which still permitted a quick recovery of the respiratory mucous membranes, with a resultant rapid subsidence of the lesions. Roentgenograms of both patients taken two days after the first views showed considerable resolution. The infiltrations were much smaller and discrete (Figs. 2 and 6). Clinically, the patients were improved. An interval examination was obtained eight days after the initial study of the first patient (Fig. 3). At this time no evidence of the original infiltrations remained. An area of atelectasis or interstitial pneumonitis was present in the right lower lung field and was felt to be a complication. No residual changes could be detected eleven months later (Fig. 4). In the second patient an interval study was obtained four days after the original examination (Fig. 7). With the exception of a few faint infiltrations in the central lung fields, the size of a match head, the lungs had almost completely cleared. The patient felt "fine" and was discharged. A follow-up study one month later revealed complete absence of residual change (Fig. 8).

#### SUMMARY

1. Two cases of inhalation pneumonia from nitric fumes are presented.
2. Although the fumes were generated under different circumstances, the pulmonary pictures appeared identical.
3. The roentgenograms were characterized by unusually extensive pseudo-

nodular infiltrations which completely studded both lung fields.

4. In these patients, both of whom recovered, there was a very rapid subsidence of the pulmonary findings, coinciding with clinical improvement. Considerable clearing could be noted after two days. Both patients were re-examined after an interval. No residual changes were noted. More extensive damage than was caused here might result in residual pulmonary changes or death.

5. We are reporting these cases because we believe that the incidence of this entity is increasing and because, as in our first patient, the condition may be unrecognized. This is significant from both a therapeutic and medicolegal standpoint.

6. It is hoped that the report of such cases will stimulate prophylactic industrial measures.

7. We prefer the less specific terminology, "inhalation pneumonia from nitric fumes" or "pneumonia complicating nitric fume poisoning" (Garland), to "nitric fume pneumonia," since we believe that other inhaled chemical irritants may cause a similar picture. Irritations of lesser severity than seen with our cases might more aptly be designated by the term "bronchiolitis."

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#### BIBLIOGRAPHY

- ADLER-HERZMARK, J.: Ein Fall von tödlicher Vergiftung durch nitrose Gase beim Lichtbogen-schweißen. *Zentralbl. f. Gewerbehyg.* 6: 193, July 1929.
- BRITTON, J. A., AND WALSH, E. L.: Health Hazards of Electric and Gas Welding. *J. Indust. Hyg.* 22: 125-151, April 1940.
- DOUB, H. P.: Pulmonary Changes from Inhalation of Noxious Gases. *Radiology* 21: 105-112, August 1933.
- ENZER, N., AND SANDER, O. A.: Chronic Lung Changes in Electric Arc Welders. *J. Indust. Hyg.* 20: 333-350, May 1938.
- GARLAND, L. H.: Metal Fume Fever and Nitric Fume Pneumonia (editorial). *Am. J. Roentgenol.* 48: 692-693, November 1942.
- HENRY, M. G.: Acute Tunnel Gas Bronchitis, with Case Report. *Indust. Med.* 8: 477-480, November 1939.
- HOLLAND, G.: Clinical Aspects of Nitrous Gas Poisoning. *Med. Klin.* 33: 930-932, July 9, 1937.
- HUMPERDINCK, C.: Examination of 40 Electric Arc Welders. *Monatschr. f. Unfallh.* 45: 359-374, July 1938. *Abst. in J. Indust. Hyg. & Toxicol.* 20: 193 (abst.), November 1938.
- JOHNSTONE, R. T.: Occupational Diseases: Diagnosis, Medicolegal Aspects, and Treatment. Philadelphia, W. B. Saunders Co., 1941, p. 204.
- KOELBEL, A.: Fatal Gas Poisoning in Acetylene Welding in a Boiler. *Arbeitsschutz*, 1938, p. 21. *Abst. in J. Indust. Hyg.* 20: 82 (abst.), April 1938.
- LA TOWSKY, L. W., MACQUIDDY, E. L., AND TOLLMAN, J. P.: Toxicology of Oxides of Nitrogen. *J. Indust. Hyg.* 23: 129-133, April 1941.
- MAENICKE, R.: Fatal Poisoning in Acetylene Welding. *Arbeitsschutz (Reichsarbeitsblatt III)*, 1936 p. 283. *Abst. in J. Indust. Hyg.* 19: 38 (abst.), February 1937.
- MACQUIDDY, E. L., TOLLMAN, J. P., LA TOWSKY, L. W., AND BAYLISS, M.: Biological Effects of Inhalation of Carbon Arc Fumes. *J. Indust. Hyg.* 20: 297-311, April 1938.
- MAWICH, R.: Fatal Poisoning in Welding with Acetylene. *Arbeitsschutz* 10: 239, 1937. *Abst. in J. Indust. Hyg.* 20: 12 (abst.), January 1938.
- M McNALLY, W. D.: Nitric Oxide Fumes: Treatment After Their Inhalation. *Indust. Med.* 11: 207-208, May 1942.
- NICHOLS, B. H.: Clinical Effects of the Inhalation of Nitrogen Dioxide. *Am. J. Roentgenol.* 23: 516-520, May 1930.
- NORDMAN, M.: Fatal Nitrous Gas Poisoning in a Closed Boiler. *Aerzt. Sachverst. Ztg.* 43: 145, 1937. *Abst. in J. Indust. Hyg.* 19: 196 (abst.), November 1937.
- RENANDER, A.: Roentgenological Changes in the Lungs Caused by Acetylene Gas. *Acta radiol.* 18: 688-692, 1937.
- SANDER, O. A.: Respiratory Hazards of Electric Arc Welding. *Indust. Med.* 8: 177-180, May 1939.
- SANTE, L. R.: The Chest. New York, Paul B. Hoeber, Inc., 1931, p. 157.
- TEBBENS, B. D., AND DRINKER, P.: Ventilation in Arc Welding with Coated Electrodes. *J. Indust. Hyg.* 23: 322-342, September 1941.
- TITUS, A. C., WARREN, H., AND DRINKER, P.: Electric Welding: The Respiratory Hazard. *J. Indust. Hyg.* 17: 121-128, July 1935.
- TOLLMAN, J. P., MACQUIDDY, E. L., AND SCHONBERGER, S.: Inhalation of Filtered Carbon Arc Fumes and Oxides of Nitrogen. *J. Indust. Hyg.* 23: 269-275, June 1941.
- VON HAAM, E., AND GROOM, J. J.: Pathology of Shielded Arc Welding. *J. Indust. Hyg.* 23: 55-77, February 1941.
- WILLIMAN, F. L.: Electric Welding: An Acute Fatal Pneumonia Following Electric Welding of Galvanized Iron in a Confined Space. *J. Indust. Hyg.* 17: 129-132, July 1935.

# Peyronie's Disease or Plastic Induration of the Penis<sup>1</sup>

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PLASTIC INDURATION of the penis, usually preferred to as Peyronie's disease—so named because this pathological entity was first described by him—has only recently attracted widespread attention. We reported 6 cases in 1934, in which radiation therapy had been given with fairly satisfactory results (6).

At that time, our search through the literature revealed some two hundred odd cases recorded. Today, we find approximately 650 cases listed by authorities from many nations. We have now studied and treated 11 more patients, as shown in the accompanying table. Though our cases constitute only a relatively small percentage of those reported, yet, from these few, together with information from more comprehensive reports of clinicians, we can draw some conclusions. The study reveals that all methods of treatment have been, and still are, largely empirical.

Surgery may be considered inadequate or, at best, applicable to only a limited number of patients with superficially localized lesions, not basically keloid. If we consider the lesion as practically purely keloidal, we can state frankly that any operative procedure, to be successful, must be accompanied by either preoperative or postoperative radiation therapy, preferably the former.

Available literature shows that encouraging results have been obtained in a goodly proportion of patients by the use of x-ray or radium alone, or the two in combination. This undoubtedly indicates some degree of sensitivity to radiation. There is, in our opinion, no ideal technic which is universally applicable. In this affliction, as in every other, one must make an individual study of each patient and apply

with common sense whatever treatment schedule is prescribed.

We have observed that the majority of patients are over forty years of age and that the main complaint is pain and distortion upon erection, with interference with coitus, which may even be impossible. It is for this particular disturbance that most patients seek relief. It is also true that if the induration is overcome, the patients in the over-fifty-years-old group complain that they no longer feel the thrill of the biological urge and hence lose interest in and respect for the doctor who is responsible for their post-treatment condition. Despite the fact that in our latest patients we have achieved the best clinical results with the 4-gm. radium pack and have screened off the testicles most carefully and thoroughly, we are apparently unable to prevent loss of libido. It appears, therefore, that the individualized long-wave radiation technic fractionated over the necessary time period is to be preferred.

Various authorities have made use of every known type of radiation, from the practically unfiltered, low quantity scale of radiation energy to the shortest wave lengths available. Strange to say, practically all of these methods have been followed by satisfactory results. This tends to prove that Peyronie's disease is definitely radiosensitive and is pathologically of true keloidal or sclerotic type. If this hypothesis is tenable, the reason for surgical failure is easily understood. On the other hand, experience has shown that keloids of all types are more easily controlled by radiation therapy in the younger generation than among the elderly. Nevertheless, the pathological factors are identical and we feel certain that a careful study of each individual patient will suggest ways and means for prescribing a

<sup>1</sup> Presented before the Radiological Society of North America, at the Twenty-eighth Annual Meeting, Chicago, Ill., Nov. 30-Dec. 4, 1942.



dose schedule from which beneficial results may be forthcoming. It is not necessary to point out that a sufferer from plastic induration of the penis, particularly in the younger group, must have relief, and, as pride goeth before a fall, he must be informed that total relief of the induration by radiation therapy may bring inability to enjoy the marital relationship to a satisfactory conclusion.

By and large, Peyronie's disease is perhaps more common than generally acknowledged, inasmuch as it is possible that many cases go unrecognized and unreported. According to Fricke (5), who has made a very careful analysis, the average duration before treatment is sought exceeds twenty months and the condition occurs most often in middle life.

The etiology still remains obscure. Numerous authors attribute the condition to trauma, venereal disease, gout, diabetes mellitus, rheumatism, tuberculosis, alcoholism, infectious disease, etc., but no conclusive proof has been offered as to any definite causative factor. Practically all keloids are resultant from trauma or chronic irritation. Therefore, it is quite reasonable to suspect an acute urethritis or a gonorrheal invasion of the urethra as the dominant factor in the causation of Peyronie's disease. We believe that this is a possible and practical assumption.

As is well known, plastic induration of the penis affects the dorsum of the sheath of the corpora cavernosa, the septum between the corpora, or both of these structures. There is an elongated thickening of these tissues, which to the palpating finger feels dense and resistant, appearing like an actual thickening of the sheaths themselves. Burford (1) emphasizes the fact that, although the condition is not common, it should be clinically recognized so that the patient may have the assurance that his condition is not malignant; also, that treatment in the hands of a competent radiologist offers a possible cure or, at least, very definite improvement.

Johnson (2) believes that surgical removal offers the best chance of cure, but

time and experience have not substantiated this statement. The consensus of opinion seems to be that x-ray therapy, radium alone, or the two in conjunction, will give the best results. McKay (3) states that surgery is not indicated and will probably prove to be harmful rather than beneficial.

In 1940, Burford (1) collected 590 cases from the literature and reported an additional 40, making a total of 630 cases reported to date. In 18 of his cases, he used the radium plaque applicator with 7 or 39 per cent cured and 8 or 45 per cent improved. Of the 19 untreated cases, 1 apparently improved spontaneously, while in the remaining 18 the condition did not change. In the other 3 cases, Burford used violet ray exposures without benefit. He maintains, like many others, that the most noticeable results are obtained by x-ray and radium, and states that a certain amount of skin irritation or even radiation necrosis may result from radium plaques.

Of a series of 80 patients reported by Fuhs (4), 27 did not complete treatment. Of those treated, 43 per cent were cured, 43 per cent improved, and 14 per cent remained unchanged.

In 1939, Fricke (5) reported on 34 cases. Two patients died suddenly of cardiac failure and were excluded from the series and 1 case was lost. Of the 31 cases traced, 18 had one treatment, with 11.2 per cent good results and 22.2 per cent fair results, while 66.6 per cent were unimproved. In 10 cases, two treatments were given with 30.0 per cent good results and 40.0 fair results, while 30.0 per cent did not improve. Three patients had three treatments: in 1 of these (33.3 per cent) results were good, in 1 fair, and 1 was unimproved.

Fricke believes that radium treatment has many advantages, as the absence of harmful after-effects, avoidance of injury to skin and edema of the tissues, and a definite time-saving element, since the treatment requires but one over-night period with a further over-night application three to four months later. He believes that the earlier the condition is treated, the better the prognosis. In the later stages,

TABLE I: PEYRONIE'S DISEASE OR PLASTIC INDURATION OF THE PENIS: ELEVEN CASES SEEN FROM 1936 TO 1942

Name of Patient and Year Treated	Age	Duration of Disease	Extent of Disease on Examination	Treatment (at Los Angeles Tumor Institute)	Present Status
E. C. D., 1936	55	2 weeks	5 × 2 cm., mid-portion	Radium	No induration
C. C. T., 1937	56	Not stated	1 × 2.5 cm., posterior portion	Radium	Lesion smaller
D. E. F., 1938	65	6 months	1 × 2 cm., posterior portion	Radium*	No induration
E. D. L.	49	1 year	Slight diffuse induration, anterior portion	None	Improved
G. B. F., 1939	58	6 months	Diffuse induration, anterior portion	Radium and 200 kv. x-rays	No induration
W. K. N., 1939	57	4 months	1.5 × 2 cm., posterior portion	Radium	Induration 50% less
A. E. O., 1940	52	4 months	Extensive induration involving and surrounding all of urethral area	200 kv. x-rays and radium	No induration
P. H. S., 1941	46	2 months	1 × 2 cm. Very dense posterior portion	Radium and 100 kv. x-rays	No evident change
L. S.	52	6 months	1 × 2 cm., surrounding posterior urethra	None (patient returned home for treatment)	
D. E. B., 1942	47	5 months	Small dense induration, mid-portion	Radium	Improved
B. B. H., 1942	68	3 months	1.5 × 3 cm., posterior portion	Radium and 100 kv. x-rays	Lesion reduced 50%

Results: Failures 1; improved 5; clinically well 4; no treatment 1.

\* This patient had previously had radium therapy elsewhere.

treatment should not be urged except as a therapeutic test.

Our own results in 6 patients treated before 1935 will be found elsewhere (6). The 11 cases seen more recently are presented in the accompanying table.

#### CONCLUSIONS

It is apparent that x-ray and radium therapy of various types have been found useful in checking the activities of plastic induration of the penis. It now remains our duty to correlate all facts gathered, to the end that a dosage schedule may be standardized which will be most effective

with the majority of patients who seek relief for this condition.

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#### REFERENCES

1. BURFORD, E. H.: Fibrous Cavernositis. *J. Urol.* 43: 208-213, January 1940.
2. JOHNSON, FRANKLIN P.: Plastic Induration of the Penis. *Northwest. Med.* 39: 22-24, January 1940.
3. MCKAY, R. W.: Fibrous Cavernositis (Peyronie's Disease). *North Carolina M. J.* 1: 484-487, September 1940.
4. FUHS, H.: Quoted by Burford.
5. FRICKE, ROBERT E., AND OLDS, J. W.: Radium Treatment of Peyronie's Disease. *Am. J. Roentgenol.* 42: 545-550, October 1939.
6. SOILAND, A., AND LINDBERG, L.: Plastic Induration of the Penis. *Am. J. Cancer* 21: 372-375, June 1934.

# A Technic for Optic Foramen Roentgenography<sup>1</sup>

BERNARD S. EPSTEIN, M.D., and MAX KULICK

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ROENTGENOGRAPHY of the optic foramina has been facilitated by the Pfeiffer angle device (1). Recently an adaptation of the Bullitt mastoid localizer for this purpose has been described (2). The necessary apparatus for these procedures, however, is often unavailable

foreshortens the optic foramen shadow, which appears as oval rather than circular. It is also somewhat difficult, with this procedure, to obtain comparable views.

We sought a method which would eliminate the use of mechanical devices and still give fairly uniform results. Satis-



FIG. 1. Position of patient for examination.

in the average roentgenologist's office or hospital, where calls for such examinations are infrequent. Under these circumstances, roentgenograms of the optic foramina usually are made by taking oblique views of the orbits. The orbital rim is pressed against the cassette and the central ray is directed from above downward, passing through the external canthus of the eye so that the orbit is portrayed as a circular shadow on the film (3). We have noted that the latter technic frequently

factory roentgenograms of the optic foramina have been obtained repeatedly with the following technic.

## TECHNIC

Place the cassette on a 2-inch block. Focus a cone with a 3-inch aperture so that the central ray passes through the center of the film. Elevate the tube and cone, and with the patient in the prone position place the head so that the malar eminence, the tip of the nose, and the superior orbital ridge form the apices of a roughly equilateral triangle in the circular roentgenographic field. Then elevate the superior orbital ridge one inch from the

<sup>1</sup> From the Radiologic Service of M. G. Wasch, M.D., The Jewish Hospital of Brooklyn. Accepted for publication in June 1943.

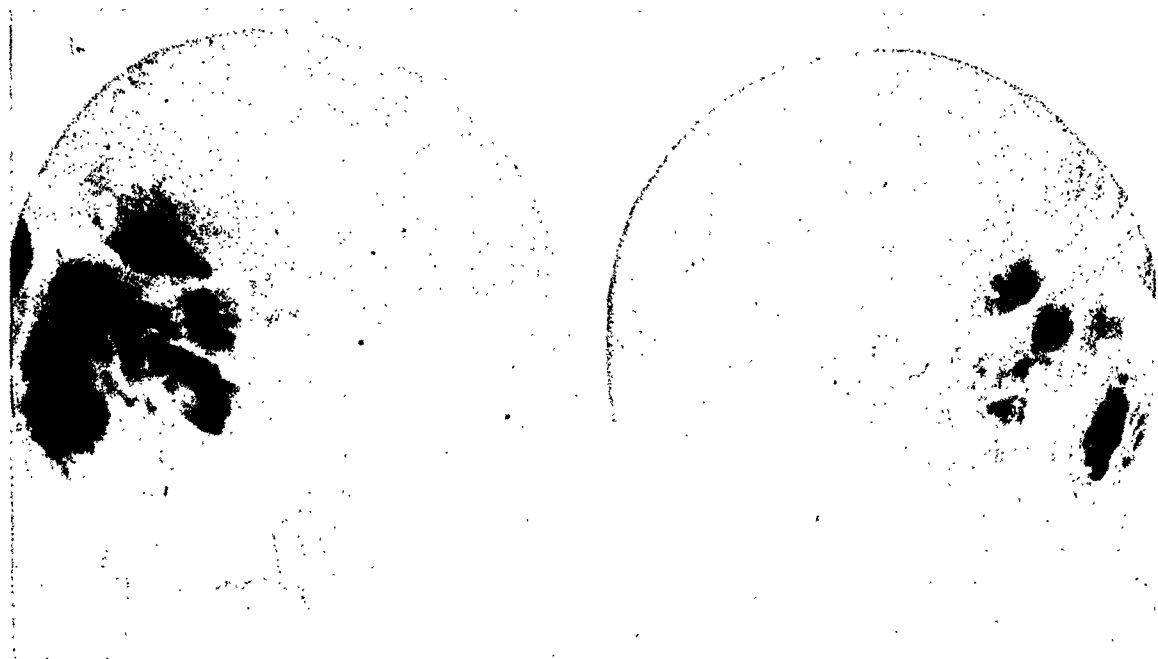


FIG. 2. Roentgenograms showing optic foramina.

cassette. A wedge of felt may be used to maintain the proper position (Fig. 1). The central ray is thereby directed perpendicularly downward, passing about 3/4-inch mesial to the external canthus of the eye. On the roentgenograms the optic foramina appear as circular structures in the lower portion of the orbits (Fig. 2).

We have obtained the same results with the use of an angle board employing a 15° angle. A slot was cut in the base into which a 5 × 7-inch or 8 × 10-inch cassette fitted. It was necessary to groove out the inclined plane to permit the cassette to be inserted its full length. The center of the roentgenographic field was marked by a cross. In use the tube is first centered over the cross, and the head is then placed so that the superior orbital ridge, the nasal tip, and the malar prominence are in contact with the inclined plane, the orbit occupying the middle area. A single view

may be obtained on a 5 × 7-inch film, or two views may be taken on an 8 × 10-inch film by masking out the appropriate fields. A lead mask may be used to pre-expose the films so that the finished roentgenogram presents a black periphery. The angle board can readily be constructed in any carpenter shop.

The physical factors used are as follows: approximately 55 kv.; 50 ma. seconds; cone 7 inches long, with 3-inch opening; screens, par speed.

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#### REFERENCES

1. PFEIFFER, R. L.: A New Technique for Roentgenography of the Optic Canals. *Am. J. Roentgenol.* 29: 410-415, March 1933.
2. EPSTEIN, B. S., AND KULICK, M.: Radiography of the Optic Foramina Employing the Bullitt Mastoid Apparatus. *Radiology* 35: 88-89, July 1940.
3. FUCHS, A. W.: Optic Foramina, Ethmoidal Sinuses and Orbits (Rhese). *Radiography & Clin. Photography* 8: 6, 1932.

# EDITORIAL

Howard P. Doub, M.D., Editor

John D. Camp, M.D., Associate Editor

## Congenital Dislocation of the Hip

There has never been a very general agreement as to the exact mechanism of congenital dislocation of the hip. It has been variously ascribed to several developmental changes. One school holds that it is primarily a bone defect, the result of deficient development of the acetabulum with poor formation of the posterior rim. Others believe that it is due to a relaxation of the capsule and ligamentous structures, with secondary bone changes resulting from the lack of articulation. It is of interest, therefore, to find a new etiological concept described in a recent communication by Badgley (1). He is unable to correlate the clinical, embryological, and anatomical facts with a theory based on a primary fault inherent in the development of the acetabulum. He cannot understand how, if such a theory were correct, so large a percentage of patients with preluxation could go on to normal development after treatment. In a series of 478 cases of preluxation of the hip, treated in the first year of life by Putti's method of abduction and internal rotation of the hip, excellent results were obtained in 94 per cent.

Badgley's contention is that the deformity is secondary to anteversion of the head and neck of the femur with a resultant secondary hypoplasia of the acetabulum. The chief evidence available of congenital dislocation of the hip in early embryonic life is to be found in arthrogryposis multiplex congenita, and for this reason a special study was made of that syndrome. The conclusion is reached that the characteristic posture of the limbs in arthrogryposis is definitely that of an arrest in development, with failure of

normal rotation of the limb bud. The extrinsic and intrinsic factors producing this arrest must be assumed to be the marked muscle atrophy and degeneration and the rigidity of joints characteristic of this condition. The "secondary acetabulum" as described in these cases is not a true secondary acetabulum but actually represents a failure of development of the anterior margin of the ilium from pressure by the femoral head. Hypoplasia of the posterior superior margin of the acetabulum, which has been supposed to be the inherent acetabular defect in congenital dislocation, may well be due to similar pressure produced by anteversion of the head of the femur rotating the neck against the posterior acetabular rim. In further support of his theory, the author calls attention to a series of 500 cases of clubfoot, with evidence of dislocation of the hip in 39, and cites Böhm's theory of the embryological origin of clubfoot as an arrest of development of the hind foot which prevents its normal rotation.

Badgley feels that there is an intrinsic design for the form of the acetabulum but that extrinsic forces play an increasing part in the later stages of development. The ultimate shape of the mature socket and head and neck of the femur is acquired adaptively by perfect timing in the alteration of the reciprocal relations of the femoral head and acetabulum coincident with growth changes. From his studies, the author advances the hypothesis that interference with the normal rotation of the limb buds, which produces an interruption in the normal turning in of the head on the socket, even temporarily, allows the head and the acetabulum to be

molded abnormally by the extrinsic factor of loss of the normal reciprocal relationship of the component parts. With more serious interference with normal rotation of the limb bud, the head is prevented from turning into the acetabulum, which is already misshapen by the loss of pressure stimulus. With continuance or resumption of torsion, anteversion increases and may lead eventually to dislocation.

Summing up his observations, Badgley concludes that congenital dislocation of the hip results from failure of normal rotation of the limb bud, with secondary flattening of the socket and anteversion of the head and neck of the femur. The anteverted femoral head points anteriorly, with the neck lying against the posterior rim of the socket and with the trochanter posteriorly. Hypoplasia of the posterior rim results from this faulty pressure. With the flat socket a gradual posterior displacement of the head and neck occurs partly as a result of the greater angle produced by the os innominatum with the acetabulum at its apex, probably aided by the pull of the gluteal muscle.

This is an interesting approach to the study of the etiology of a condition which is frequently encountered and which is not always easy to correct.

\* \* \* \* \*

An interesting review of the end-results of bloodless reduction of congenital dislocation of the hip is given by Gill (2), though he found it difficult to arrive at definite percentages of cure since many of the patients drifted away and were lost sight of. Ninety-eight cases were available for study during the second year after reduction, and of these 14 (14.3 per cent) showed a perfect result, and 7 (7.1 per cent) results which may be called excellent. Fifty-five of this group were operated upon, and 9 had redislocation without subsequent operation, making a total of 64 cases, or 65.3 per cent of the series, having proved unsuccessful reductions. The satisfactory results would therefore lie between 21.4 and 34.7 per cent. The

author stresses the fact, however, that these percentages are of relative value only, as some of the patients who disappeared showed excellent results up to that time and others can be expected to suffer relapse even as late as the twentieth year.

In bilateral dislocations, where reduction was possible, the end-results were as good as in single dislocations. It should be noted, however, that it is in bilateral dislocations that the very severe degrees of congenital deformity occur.

Failure of cases to remain reduced after removal of the fixation dressings and resumption of the original leg position proved that many hips are not amenable to successful bloodless reduction. The author has never operated in one of these unsuccessful cases, however, without discovering some pathological condition to account for the failure. Many relapses occurring in later years are attributable to failure of development of the acetabular roof.

Gill advocates the shelf operation for those cases in which bloodless reduction is not successful but delays operation until the child has passed the age of five.

The question may be raised whether bloodless reduction is worth while in view of the above statistics. Answering it, Gill calls attention to the fact that 16 per cent of the total number of his patients and 30 per cent of those in whom the end-result was observed for eight or more years have stable painless hips and lead normal lives. In addition, 19 per cent enjoyed normal function for from five to twenty years before operation became necessary, while in others primary reduction of the hip made possible a successful shelf operation. Without primary reduction all operative procedures in later years are solely palliative, without restoration of normal function.

#### REFERENCES

1. BADGLEY, CARL E.: Correlation of Clinical and Anatomical Facts Leading to a Conception of the Etiology of Congenital Hip Dysplasias. *J. Bone & Joint Surg.* 25: 503-523, July 1943.
2. GILL, A. BRUCE: End Results of Bloodless Reduction of Congenital Dislocation of the Hip. *J. Bone & Joint Surg.* 25: 1-40, January 1943.

## SAN DIEGO ROENTGEN SOCIETY

Largely through the efforts of Dr. Harry A. Keener, Senior Medical Officer in Roentgenology at the Naval Hospital, there has recently been organized a San Diego (California) Roentgen Society for local radiologists and service men. The Society meets on the first Wednesday of each month for dinner and a case seminar. Dr. Henry L. Jaffe, of Chicago, now stationed at the Naval Hospital, Balboa Park, is secretary.

## Letter to the Editor

### DYSCHIEZIA AND MEGACOLON

To the Editor

Dear Sir:

I appreciate your courtesy in submitting to me the proof of the paper on *Dyschezia and Megacolon* by Sir Arthur Hurst, which is to appear in the February issue of *RADIOLOGY*, thus giving me an opportunity to defend my position.

In reply to Hurst's statement that there had never been any confusion between the two conditions until my colleagues and I introduced it, and to the further charge that we had apparently not read any of the "numerous papers" which have appeared on the subject, I would like first of all to remind him that he fails to state what these "numerous papers" are. His bibliography consists of but seven references, including one to a paper which he has only recently published. The fact that he gives no evidence of having covered the literature sheds an important light on some of the conclusions he attempts to draw as he proceeds with his argument. While I make no claim to have exhausted the resources of the local libraries in reinforcing my conclusions, I did list thirty of the references I consulted, which I should regard as a minimum for exploring a subject as intricate as that of megacolon.

Hurst starts out by saying that normal defecation depends on a "conditioned reflex"—in which getting up, taking a bath, dressing, breakfast, reading a newspaper, and smoking a pipe all participate—and would have us believe that the establishment of such a reflex is of great importance in normal bowel habit. He then goes on to say that "in most cases of dyschezia this conditioned reflex is unimpaired, but"—and the italics are mine—"for various reasons it is not followed by the defaecation reflex proper, in which the rectum contracts and the anal sphincter relaxes, so that the rectum is found to be packed with faeces at whatever hour it is examined."

He continues by describing the manner in which

the defecation reflex fails to function, because of failure to heed it, and pictures an individual who is becoming increasingly distressed by symptoms of pressure from a dilated and distended rectum, though he points out at the same time that normal sensation has become so impaired that the call to defecate is neglected. These conflicting statements would seem to reach the height of confusion.

I have objected to the term *dyschezia* as failing to represent a clinical entity, just as pain in the chest or fever cannot be said to represent such an entity. For my critic's conception of *dyschezia*, we may examine some of his published statements. In the section on "Constipation" in French's *Differential Diagnosis*—in many respects an excellent textbook—Hurst writes: "Fibrous stricture of the rectum is an occasional cause of *dyschezia*, especially in women . . ." and again: "Cancer of the rectum or pelvic colon is a grave cause of *dyschezia* . . ." I still insist that he is not talking about a clinical entity.

I wish particularly to draw attention to the illustration on page 159 of French's book (Fourth Edition). Here Hurst pictures a condition which is essentially the same as the one illustrated in my article to which he takes exception. The rectal ampulla and lower sigmoid are dilated far beyond the degree which could occur in a normal person who had merely neglected emptying the bowel on occasion. There can be no question about that. Furthermore, the patients who are the subjects of such a condition have exhausted every means in their power to empty the rectum. They have employed cathartics and enemas, and finally consulted a physician. Hurst labels this illustration "*Dyschezia in a boy of 10, associated with chronic inflammation of a tender pelvic appendix . . .*" (More confusion!) There can be no question that this illustration and that in my own paper both represent instances of segmental megacolon.

Hurst next turns to the subject of megacolon, stating that the condition is rare in children. Here he is at variance with all published material on the subject, as megacolon is universally recognized as first making its appearance in childhood, save for those exceptional cases in which disease or injury of the nervous system may have produced something like it in later life. That Hurst sees the condition most often in adults may be due to the fact that some of his patients did not consult a physician until they were fully grown.

As to pathogenesis, he states: "I believe that the primary factor in the pathogenesis of all cases of megacolon is achalasia of the sphincter ani . . . This is sufficient to prevent the easy evacuation of faeces, which are consequently retained." Now, having given us a brave start in this direction, he goes on

to the symptoms, stating: "Digital examination of the rectum is painless; the *anal canal offers no more than the normal bowel resistance*"—again the italics are mine—"and there is no hypertrophy of the sphincter." Confusion?

When he comes to the matter of treatment, Hurst writes: "The main object in the treatment of megacolon is to lessen the resistance of the closed anal sphincter to the passage of faeces and gas." After stating that sympathectomies have been done with good results in boys but not in adults, he adds: "but equally good results could be very much more simply attained by local treatment." Is that statement intended to imply that all that has been claimed by neurosurgeons for the results of early sympathectomy has been in error, and that they have wholly overlooked the fact that some rectal dilatations could have given equally good results?

Incredibly enough, Hurst concludes with this statement: "It seems likely that the improvement following sympathectomy was really the result of the spinal anesthetic used for the operation or for diagnostic purposes. In any case there is now no excuse for performing sympathectomy, but a spinal anesthetic should be used in place of general anesthesia when difficulty is experienced in emptying the rectum and pelvic colon by enemas alone." May I point out that the effect of a spinal anesthetic is not a permanent one, that the blocking of certain nerve impulses lasts only as long as the anesthesia, and that such a procedure cannot replace the permanent interruption of certain nerve pathways such as may be achieved by their surgical removal?

In closing I reiterate the plea made in the original article, that the term "rectal dyschezia" be relegated to the niche in medicine where it belongs, along with laudable pus, the Lister spray, and the fallen stomach.

PERCY J. DELANO, M.D.

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## In Memoriam

### LESTER WHITE BAIRD

The death of Capt. Lester W. Baird, of coronary sclerosis, occurred on Oct. 6, 1943, at Camp Carson, Colorado Springs, Colorado.

Doctor Baird was born on April 19, 1907, in Edwardsville, Ill., the son of Henry N. Baird and Maude White Baird. He was graduated from the Edwardsville High School and obtained his M.D. from the University of Illinois in 1932, after which he spent two years, as intern and resident, at the Santa Clara County Hospital, San Jose, Calif. He had a three-year Fellowship in Radiology at the Mayo Clinic, and obtained the degree of Master of Science in Radiology from the Graduate School of the University of Minnesota. Leaving the Mayo Clinic in December 1936, he became radiologist at

the Scott & White Clinic and the Santa Fe Hospital in Temple, Texas, where he remained until he entered the Army as a Captain in the Medical Corps, in November 1942. He was stationed at Camp Carson as head of the Radiological Department from that time until his death.

Doctor Baird was a member of the Bell County Medical Society, the Texas State Medical Society, and the Radiological Society of North America. He was a diplomate of the American Board of Radiology and a member of the American College of Radiology. He served as secretary of the Texas Radiological Society in 1941-42. He was a member of the Phi Beta Pi medical fraternity.

Doctor Baird had written scientific papers and appeared on the programs of local, state and national organizations. He conducted a refresher course in Carcinoma of the Colon for members of the Radiological Society of North America at their annual meeting in California in December 1941.

C. A. STEVENSON, M.D.

## Book Review

THE ARTHROPATHIES: A HANDBOOK OF ROENTGEN DIAGNOSIS. By ALFRED A. DE LORIMIER, A.B., M.A., M.D., Colonel, Medical Corps, United States Army; Commandant, The Army School of Roentgenology, Memphis, Tenn. Formerly Director, Department of Roentgenology, Army Medical School, Washington, D. C. A volume of 319 pages with 678 figures. Published by The Year Book Publishers, Inc., Chicago, 1943. Price \$5.50.

This volume by the head of the U. S. Army School of Roentgenology is the first of a new series of handbooks of roentgen diagnosis which will cover the various systems of the body. It is in the form of an atlas, presenting essential information in a highly condensed style. There are abundant illustrations with many full page plates.

In the introduction Colonel de Lorimier discusses basic factors of technic in the demonstration of soft tissues as well as osseous structures. He then outlines the studies to be made of the various structures of the joints and the correlation of the clinical history to the end that a more exact roentgen diagnosis may be made. In subsequent chapters the arthropathies are described individually, in outline form, with identical headings, which greatly facilitate comparison of particular features of different diseases. Under each condition are given the synonyms, direct roentgen criteria, incidence, history, physical and laboratory findings, and clinical course. A bibliography follows each chapter.

This book is recommended for students of roentgenology and roentgenologists not as an exhaustive treatise on arthritis but for a concise and orderly summary of the arthritides.



# RADIOLOGICAL SOCIETIES OF NORTH AMERICA

*Editor's Note.*—Will secretaries of societies please cooperate by sending information to Howard P. Doub, M.D., Editor, Henry Ford Hospital, Detroit 2, Mich.

## UNITED STATES

*Radiological Society of North America.*—Secretary, D. S. Childs, M.D., 607 Medical Arts Building, Syracuse, N. Y.

*American Roentgen Ray Society.*—Secretary, Harold Dabney Kerr, M.D., Iowa City, Iowa.

*American College of Radiology.*—Secretary, Mac F. Cahal, 540 N. Michigan Ave., Chicago, Ill.

*Section on Radiology, American Medical Association.*—Secretary, J. T. Murphy, M.D., 421 Michigan St., Toledo, Ohio.

## ARKANSAS

*Arkansas Radiological Society.*—Secretary, J. S. Wilson, M.D., Monticello. Meets every three months and annually at meeting of State Medical Society.

## CALIFORNIA

*California Medical Association, Section on Radiology.*—Secretary, Earl R. Miller, M.D., University of California Hospital, San Francisco, Calif.

*Los Angeles County Medical Association, Radiological Section.*—Secretary, Donald R. Laing, M.D., 65 N. Madison Ave., Pasadena. Meets second Wednesday of each month at County Society Building.

*Pacific Roentgen Society.*—Secretary, L. Henry Garland, M.D., 450 Sutter St., San Francisco. Meets annually during meeting of California Medical Association.

*San Diego Roentgen Society.*—Secretary, Henry L. Jaffe, M.D., Naval Hospital, Balboa Park, Calif. Meets first Wednesday of each month.

*San Francisco Radiological Society.*—Secretary, Sydney F. Thomas, M.D., San Francisco Hospital. Meets monthly on third Thursday at 7:45 p.m., in Toland Hall, University of California Hospital.

## COLORADO

*Denver Radiological Club.*—Secretary, Edward J. Meister, M.D., 366 Metropolitan Bldg. Meetings third Friday of each month at the Denver Athletic Club.

## CONNECTICUT

*Connecticut State Medical Society, Section on Radiology.*—Secretary, Max Climan, M.D., 242 Trumbull St., Hartford. Meetings bimonthly, on second Thursday.

## FLORIDA

*Florida Radiological Society.*—Acting Secretary, Walter A. Weed, M.D., 204 Exchange Building, Orlando.

## GEORGIA

*Georgia Radiological Society.*—Secretary-Treasurer, James J. Clark, M.D., 478 Peachtree St., N. E., Atlanta. Meetings twice annually, in November and at the annual meeting of State Medical Association.

## ILLINOIS

*Chicago Roentgen Society.*—Secretary, Warren W. Furey, M.D., 6844 S. Oglesby Ave. Meets at the Palmer House, second Thursday of October, November, January, February, March, and April.

*Illinois Radiological Society.*—Secretary-Treasurer, William DeHollander, M.D., St. Johns' Hospital, Springfield. Meetings quarterly by announcement.

*Illinois State Medical Society, Section on Radiology.*—Secretary, Fay H. Squire, M.D., 1753 W. Congress St., Chicago.

## INDIANA

*The Indiana Roentgen Society.*—Secretary-Treasurer, Harold C. Ochsner, M.D., Methodist Hospital, Indianapolis. Annual meeting in May.

## IOWA

*The Iowa X-ray Club.*—Holds luncheon and business meeting during annual session of Iowa State Medical Society.

## KENTUCKY

*Kentucky Radiological Society.*—Secretary-Treasurer, Sydney E. Johnson, M.D., Louisville City Hospital, Louisville. Meeting annually in Louisville, third Saturday afternoon in April.

## LOUISIANA

*Louisiana Radiological Society.*—Secretary-Treasurer, Johnson R. Anderson, M.D., North Louisiana Sanitarium, Shreveport. Meets annually at same time as State Medical Society.

*Shreveport Radiological Club.*—Secretary-Treasurer, R. W. Cooper, 940 Margaret Place. Meetings monthly on the second Wednesday; at the offices of the various members.

## MARYLAND

*Baltimore City Medical Society, Radiological Section.*—Secretary, Walter L. Kilby, M.D., 101 W. Read St. Meetings are held the third Tuesday of each month.

## MICHIGAN

*Detroit X-ray and Radium Society.*—Secretary-Treasurer, E. R. Witwer, M.D., Harper Hospital, Detroit. Meetings first Thursday of each month from October to May, inclusive, at Wayne County Medical Society club rooms, 4421 Woodward Ave., Detroit.

*Michigan Association of Roentgenologists.*—Secretary-Treasurer, E. M. Shebesta, M.D., 1429 David Whitney Bldg., Detroit. Meetings quarterly by announcement.

## MINNESOTA

*Minnesota Radiological Society.*—Secretary, John P. Medelman, M.D., 572 Lowry Medical Arts Bldg., St. Paul. Meetings quarterly.

## MISSOURI

*Radiological Society of Greater Kansas City.*—Secretary, Arthur B. Smith, M.D., 306 E. 12th St., Kansas City, Mo. Meetings last Thursday of each month.

*The St. Louis Society of Radiologists.*—Secretary, Paul C. Schnobelen, M.D., 462 N. Taylor Ave. Meets on fourth Wednesday of each month except June, July, August, and September, at a place designated by the president.

## NEBRASKA

*Nebraska Radiological Society.*—Secretary, F. L. Simonds, M.D., 1216 Medical Arts Bldg., Omaha. Meetings third Wednesday of each month at 6 p.m. in either Omaha or Lincoln.

## NEW ENGLAND

*New England Roentgen Ray Society* (Maine, New Hampshire, Vermont, Massachusetts, and Rhode Island).—Secretary, Hugh F. Hare, M.D., Lahey Clinic, Boston, Mass. Meets monthly on third Friday at Boston Medical Library.

## NEW JERSEY

*Radiological Society of New Jersey.*—Secretary, H. J. Perlberg, M.D., Trust Co. of New Jersey Bldg., Jersey City. Meetings at Atlantic City at time of State Medical Society and midwinter in Newark as called by president.

## NEW YORK

*Associated Radiologists of New York, Inc.*—Secretary, William J. Francis, M.D., 210 Fifth Ave., New York City. Regular meetings the first Monday evening of the month in March, May, October, and December.

*Brooklyn Roentgen Ray Society.*—Secretary-Treasurer, Leo Harrington, M.D., 880 Ocean Ave. Meetings held the fourth Tuesday of every month, October to April.

*Buffalo Radiological Society.*—Secretary-Treasurer, Joseph S. Gianfranceschi, M.D., 610 Niagara St. Meetings second Monday evening each month, October to May, inclusive.

*Central New York Roentgen Ray Society.*—Secretary-Treasurer, Carlton F. Potter, M.D., 425 Waverly Ave., Syracuse. Meetings are held in January, May, and October, as called by Executive Committee.

*Long Island Radiological Society.*—Secretary, Marcus Wiener, M.D., 1430 48th St., Brooklyn. Meetings fourth Thursday evening each month at Kings County Medical Bldg.

*New York Roentgen Society.*—Secretary, Haig H. Kasabach, Presbyterian Hospital, New York, N. Y.

*Rochester Roentgen-ray Society.*—Secretary, S. C. Davidson, M.D., 277 Alexander St. Meetings at convenience of committee.

## NORTH CAROLINA

*Radiological Society of North Carolina.*—Secretary-Treasurer, Major I. Fleming, M.D., 404 Falls Road, Rocky Mount. Meeting with State meeting in May, and meeting in October.

## NORTH DAKOTA

*North Dakota Radiological Society.*—Secretary, L. A. Nash, M.D., St. John's Hospital, Fargo. Meetings by announcement.

## OHIO

*Ohio Radiological Society.*—Secretary, J. E. McCarthy, M.D., 707 Race St., Cincinnati. The next meeting will be held at the time and place of the annual meeting of the Ohio State Medical Association.

*Cleveland Radiological Society.*—Secretary-Treasurer, Don D. Brannan, M.D., 11311 Shaker Blvd., Cleveland 4. Meetings at 6:30 P.M. on fourth Monday of each month from October to April, inclusive.

*Radiological Society of the Academy of Medicine (Cincinnati Roentgenologists).*—Secretary-Treasurer, Samuel Brown, M.D., 707 Race St. Meetings held third Tuesday of each month.

## PENNSYLVANIA

*Pennsylvania Radiological Society.*—Secretary-Treasurer, L. E. Wurster, M.D., 416 Pine St., Williamsport. The Society meets annually.

*The Philadelphia Roentgen Ray Society.*—Secretary, Robert P. Barden, M.D., 3400 Spruce St., Philadelphia. Meetings held first Thursday of each month at 8:15 P.M., from October to May, in Thomson Hall, College of Physicians, 21 S. 22nd St., Philadelphia.

*The Pittsburgh Roentgen Society.*—Secretary-Treasurer, Reuben G. Alley, M.D., 4800 Friendship Ave., Pittsburgh, Pa. Meetings are held on the second Wednesday of each month at 4:30 P.M., from October to June, at the Pittsburgh Academy of Medicine, 322 N. Craig St.

## ROCKY MOUNTAIN STATES

*Rocky Mountain Radiological Society* (North Dakota, South Dakota, Nebraska, Kansas, Texas, Wyoming, Montana, Colorado, Idaho, Utah, New Mexico).—Secretary, A. M. Popma, M.D., 220 North First St., Boise, Idaho.

## SOUTH CAROLINA

*South Carolina X-ray Society.*—Secretary-Treasurer, Robert B. Taft, M.D., 103 Rutledge Ave., Charleston. Meeting in Charleston on first Thursday in November, also at time and place of South Carolina State Medical Association.

## TENNESSEE

*Memphis Roentgen Club.*—Chairmanship rotates monthly in alphabetical order. Meetings second Tuesday of each month at University Center.

*Tennessee Radiological Society.*—Secretary-Treasurer, J. Marsh Frère, M.D., 707 Walnut St., Chattanooga. Meeting annually with State Medical Society in April.

## TEXAS

*Texas Radiological Society.*—Secretary-Treasurer, Herman Klapproth M.D., Sherman.

## VIRGINIA

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*Milwaukee Roentgen Ray Society.*—Secretary-Treasurer, C. A. H. Fortier, M.D., 231 W. Wisconsin Ave., Milwaukee. Meets monthly on second Monday at the University Club.

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## CUBA

*Sociedad de Radiología y Fisioterapia de Cuba.*—Offices in Hospital Mercedes, Havana. Meetings are held monthly.

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## THE HEAD AND NECK

**Note on the Identification of Skulls by X-ray Pictures of the Frontal Sinuses.** Arthur Schuller. M. J. Australia 1: 554-556, June 19, 1943.

The most striking feature of the roentgenographic appearance of the pneumatic spaces of the skull is the individual variation in size and configuration.

The frontal sinuses develop as extensions from the nasal cavities and are clearly seen in the second year of life. They grow slowly until puberty and then increase rapidly until the twentieth year. They are absent in about 5 per cent of adults studied roentgenographically; unilateral absence is seen in 1 per cent. Persistence of the frontal suture, demonstrable on postero-anterior roentgenograms, is often combined with absence of the frontal sinuses. Persistence of this suture is most frequent in Europeans (8.7 per cent) and least in Negroes (1.2 per cent) and Australian aborigines (1 per cent). The sinuses do not pass over the mid-line in these cases because of the thick central plate.

In female skulls the arcades of the scalloped upper border are smaller and more numerous than in the male. Pneumatic cavities of the skulls of identical twins are similar, but not identical. Thinning of the walls of the frontal sinuses in the elderly is due to a compensatory enlargement associated with shrinking of the frontal lobes of the brain. Occasionally, in the senile skull, a cavity may be formed due to atrophy of the diploe, communicating with the frontal sinuses. Hyperostosis frontalis may also produce changes in the size and shape of these sinuses.

Constitutional and hormonal factors may cause either hypopneumatization or hyperpneumatization. In cretinism the pneumatization is poor and in acromegaly the sinuses are often very large. Large frontal sinuses are seen in microcephalia, probably compensating for the hypoplasia of the brain.

Obstruction of the frontonasal duct due to inflammatory processes, injuries, or new growths may cause enlargement of the frontal sinuses. Acute or chronic inflammations tend to decrease the density of the compact lamina which outlines the cavity. Abnormalities of the frontal sinuses are seen in Paget's disease, osteofibrosis cystica, leontiasis ossea, osteoma, and osteosarcoma of the frontal bone.

A method is presented of describing the configuration and measuring the extension of the frontal sinuses in roentgenograms of skulls taken in the standard forehead-nose position, for the purpose of anthropometric identification by comparison with x-ray pictures formerly taken.

DONALD R. LAING, M.D.

**Spina Bifida and Cranium Bifidum: Unusual Nasopharyngeal Encephalocele.** Franc D. Ingraham and Donald D. Matson. New England J. Med. 228: 815-820, June 24, 1943.

This is an extensive and complete case report of multiple congenital deformities in a child, with attention centered about the protrusion of brain tissue into the nasal cavity. Roentgen studies showed absence of normal bone structures in the region of the cribriform plate and obliteration of most of the ethmoid cells. There were also harelip and cleft palate, through which the protruding brain tissue could be seen. Intracranial

removal and repair of the defect were accomplished with excellent result.

JOHN B. McANENY, M.D.

**Spina Bifida and Cranium Bifidum: Arnold-Chiari Malformation: Study of 20 Cases.** Franc D. Ingraham and H. William Scott, Jr. New England J. Med. 229: 108-114, July 15, 1943.

The Arnold-Chiari malformation is characterized by a congenital elongation of the cerebellum and brain stem into the cervical spinal canal. Penfield and Coburn (Arch. Neurol. & Psychiat. 40: 328, 1938) believed it to be due to downward traction on the brain stem in embryonic life as a result of fixation of the cord at the site of a meningocele. Cases resembling the malformation described by Arnold and Chiari have, however, been reported without an associated spina bifida meningocele, which would suggest the possibility of some other mechanism.

The authors studied a series of 20 cases of this malformation, in 19 of which autopsy reports were available. The patients ranged in age between 2 days and 18 months. Meningocele was present in all.

The pathological process constantly found was exactly that originally described by Arnold—a prolongation of two tongue-like processes from the inferior poles of the cerebellar hemispheres through the foramen magnum and closely applied to the posterior surface of the medulla. Between one-half and two-thirds of the medulla was below the level of the foramen magnum and was elongated, narrowed, and compressed in its anteroposterior diameter. The fourth ventricle was elongated and flattened, and its lumen almost obliterated. The foramina of Magendie and Luschka lay below the level of the foramen magnum and were identified with difficulty. The upper cervical roots were found to run upward rather than downward, as is their normal course.

Spina bifida and myelomeningocele were present in all 20 cases, and dense fibrous adhesions were found binding the myelomeningocele to the vertebral defect.

Internal hydrocephalus was present in all cases. This may result in one of several ways: mechanical obstruction of the fourth ventricle or foramina of Magendie and Luschka; obliteration of the subarachnoid space by pressure of the herniated hindbrain while the fourth ventricle remains intact; aseptic inflammation and plastic exudate in the subarachnoid space from pressure irritation.

All cases showed microgyria. Craniolacunia was present in 15 cases and may have been present in the other 5. Hydromyelia occurred in 8 cases. Platybasia was seen 3 times and the Klippel-Feil syndrome was encountered once.

JOHN B. McANENY, M.D.

**Roentgen Diagnosis of Malignant Nasopharyngeal Tumors.** W. George Belanger and Cornelius G. Dyke. Am. J. Roentgenol. 50: 9-17, July 1943.

Fourteen cases of malignant nasopharyngeal tumor were studied by the authors. Tumors in this area grow downward into the lumen of the nasopharynx and upward toward the base of the skull. Osseous changes consist of both proliferation and destruction, but only two cases in the present series exhibited proliferation. Destruction of one or more structures in

the base of the skull is the key to the roentgen diagnosis of these tumors. The three structures most frequently involved were: (1) the body of the sphenoid bone, (2) the basi-occiput, and (3) the medial margin of the great wing of the sphenoid bone. The apex of the petrous portion of the temporal bone and the foramina ovale and spinosum were involved less frequently. Stereoscopic roentgenograms taken in the basal position are of utmost importance. Study of the lateral roentgenogram, however, will often give a valuable clue and stimulate further study. Sometimes the osseous destruction is rapid, so that continued observation of a case under suspicion is advisable.

Soft-tissue changes are also of importance. They consist essentially of changes in the paranasal sinuses, manifested by clouding or sinusitis, and the presence of a mass either in the nasopharynx, the sphenoidal sinus, or both. In not a few of the cases seen by the authors, the roentgen diagnosis of nasopharyngeal cancer represented the first time that such a diagnosis of the patient's disease had been seriously considered. The importance of roentgenologic diagnosis is obvious when we consider the great difficulty of recognizing nasopharyngeal cancer clinically. By definitely establishing the diagnosis we may prevent unfortunate and useless surgical procedures. The only successful treatment of these tumors is by radiation therapy.

CLARENCE E. WEAVER, M.D.

**Osteochondroma of the Coronoid Process of the Mandible.** Richard T. Shackelford and Webster H. Brown. Surg., Gynec. & Obst. 77: 51-54, July 1943.

The authors present two cases of osteochondroma of the coronoid process of the mandible, previous reports of which they have been unable to find in the literature. Both cases were in boys in their teens. The lesions which are described are similar in every respect to osteochondromas in general except for their unusual location on the coronoid process. The first case remained undiagnosed for several years, the nature of the lesion not having been recognized.

The authors list as the important points in diagnosis: slowly progressive, painless limitation of movement of the jaw in young persons, malocclusion in some cases, a bony-hard swelling in the region of the zygoma, and the abnormal bony projection demonstrable in roentgenograms taken from the proper angles.

Treatment consists of surgical removal of the growth. The authors' procedure consists in resection of the zygoma, after which the tumor is easily seen and resected. The zygoma is then replaced *in toto* or, if resected in sections, is replaced after threading on a stainless steel wire. The operative procedure was not followed by any disturbance of the facial or trigeminal nerves or of Stenson's duct, and the immediate and subsequent postoperative results were good.

ELLIS C. OSGOOD, M.D.

## THE CHEST

**Types of Lung Diseases Encountered in an Army Camp.** Morris C. Thomas. Am. Rev. Tuberc. 48: 1-7, July 1943.

A brief résumé of the types of lung diseases encountered in a large army camp is presented. Cases of definite tuberculosis are few in number due to the rigid standards employed for the induction examination.

The majority of cases found are discovered on routine chest films taken for varied reasons rather than because of the presence of suggestive or definite symptoms.

Bronchiectasis is a more common disease than tuberculosis, probably because, except in the well advanced stages, it cannot be diagnosed at the induction centers so easily or accurately as can tuberculosis. About one-fourth of the patients are admitted to the hospital because of suggestive symptoms. In the others the condition is suspected from routine films usually because of slow convalescence from a respiratory infection or from a supposed pneumonia. Since the symptoms are unreliable and may be misleading, the policy has been adopted of doing iodized oil instillations on all men who show abnormal basal markings, shifting of the heart, or delayed resolution of a pneumonia.

Pneumonias account for the largest group of major pulmonary infections. Pneumococcal pneumonia forms only a small group. Most of the cases of pneumonia belong to the group reported officially as bronchopneumonia, atypical pneumonia, or pneumonia unclassified. This type of the disease was first encountered in February 1941. Since then it has undergone several changes both in its clinical manifestations and x-ray appearances. If the blood counts are used as criteria, two groups can be developed. Cases showing an initial leukocytosis may be classed as bacterial in origin and related to some type of bronchiopneumonia. Those showing normal leukocyte counts may be grouped with the atypical or virus pneumonias. Such a differentiation, however, cannot be made clinically.

In general, soldiers are subject to the same diseases to be encountered in civilian life, and the cases seen are essentially of the same types anticipated in a comparable age group in civilian practice. Prompt hospitalization of the sick permits the study and observation of the early manifestations of many diseases. It has demonstrated that the accepted early symptoms are sometimes not "early." Observation of diseases under such controlled conditions emphasizes the fact that the clinical findings present in a given entity are neither fixed nor constant but are altered and varied by the individual's reaction to his infection.

L. W. PAUL, M.D.

**Primary Atypical Pneumonia: Report of 200 Cases at Fort Eustis, Virginia.** Thomas A. Campbell, Paul S. Strong, George S. Grier, III, and R. J. Lutz. J. A. M. A. 122: 723-729, July 10, 1943.

So-called atypical pneumonia is more correctly designated as an "acute bronchiolitis with associated atelectasis." In a review of 200 cases of this currently popular pulmonary entity, which the authors suggest has existed for many years, special emphasis is placed upon its epidemiology, pathology, and clinico-roentgenological aspects.

It is pointed out that the disease occurs both endemically and in minor epidemics, the latter appearing largely in late fall or early winter months. The incubation period is between seven and twenty-one days and, while the condition is not highly contagious, prolonged contact results in a high incidence.

Roentgenologically, 81 per cent of the pulmonary lesions were basilar. These were characterized by a streaking type of density which radiated downward from the hilum and extended outward over the diaphragmatic dome. Superimposed on the stringy density was a mottled density, which was seen most

frequently at the right median base and along the left heart border. The stringy density was interpreted as a manifestation of bronchitis and bronchiolitis, and the mottled shadows were thought to represent a lobular form of atelectasis. The evanescence and variability of the pulmonary lesions, plus the fact that 19 per cent of the patients had some mediastinal shift, elevation of diaphragm, or interspace narrowing, tended to support the presence of atelectasis.

Apical lesions had to be differentiated from tuberculosis, and compression atelectasis, which was frequently encountered at the lung bases, required proper evaluation. Pleural fluid was encountered in only 6 per cent of cases. As in pneumococcal pneumonia, the roentgen signs of resolution in atypical pneumonia tended to lag behind clinical improvement.

DEPARTMENT OF ROENTGENOLOGY  
UNIVERSITY OF MICHIGAN (J. H.)

**Fatal Case of Atypical Pneumonia with Encephalitis.** Hector Perrone and Myron Wright. *Brit. M. J.* 2: 63-65, July 17, 1943.

The author presents a rather detailed case history of a patient who had atypical pneumonia with encephalitis and came to autopsy, where the condition of the brain and meninges was apparent. Three other cases of atypical pneumonia are reported where the patients showed all the evidences of encephalitis but the outcome was not fatal. In introducing the subject, a few random comments are made as to the etiological features of virus pneumonia and its relation to psittacosis, lymphogranuloma inguinale, and other conditions. The x-ray findings are discussed and described as large consolidated areas consisting of numerous soft, coarse shadows.

In the fatal case reported the postmortem findings in the brain consisted of dark brown pigmented areas in the cerebrum without significant changes elsewhere. The pathological diagnosis was acute encephalitis. At the time of autopsy the pneumonic condition was beginning to subside. Q. B. CORAY, M.D.

**Diagnosis of Virus Pneumonitis in Infancy.** John L. Gedgoud. *Nebraska M. J.* 28: 51-53, February 1943.

The author discusses the findings in 74 cases of virus pneumonitis in infancy reported by Adams (*J. A. M. A.* 116: 925, 1941; *J. Pediat.* 20: 405, 1942) and presents 2 fatal cases from the University Hospital, Omaha. In Adams' series the mortality was 15, which is in marked contrast to the low mortality observed in clinically recognized adult cases. Clinical signs in the 74 cases varied from cough without fever to cough, dyspnea, cyanosis, and high fever. Little was detectable on chest examination. The roentgenogram may reveal only an indefinite accentuation of lung markings or may show definite areas of consolidation. These cases do not respond to sulfonamide therapy.

The cases which the author reports show the errors which may be made before arriving at the correct diagnosis. One patient, a two-year-old girl, appeared at the dispensary with cough and hoarseness of three days' duration, preceded by a "slight cold." Physical examination revealed a reddened pharynx and tonsils and some fine râles scattered throughout both lungs. That evening dyspnea and rapid respiration developed. The respiratory embarrassment was thought to be due to asthma and treatment was instituted with no effect.

Fluoroscopy showed a severe emphysema and a possible foreign body in the larynx. There was no consolidation. Bronchoscopy failed to reveal a foreign body or inflammation of the larynx or trachea, but did show the picture of acute asthmatic collapse. A tracheotomy was done. As the patient's condition became worse despite treatment, it was realized that the obstruction was peripheral and not asthmatic in nature and a tentative diagnosis of "capillary bronchiolitis" or virus pneumonitis was made. The child became progressively weaker and died three days after admission, the eighth day after the onset of cough. A roentgenogram of the chest on the day of death showed an obstructive emphysema and a smear from the tracheal exudate showed cytoplasmic inclusion bodies in epithelial cells, confirming the diagnosis of pneumonitis of virus origin.

The second patient was a six-month-old white girl, who was admitted on July 14, 1942, with a history of vomiting for two weeks and a weight loss of 5 pounds in the preceding month. During June she suffered periods of irritability, anorexia, and alternate constipation and diarrhea. On July 9 she had entered a local hospital with "blue hands and feet." Fluids by clysis and gavage feedings did not bring relief. The mother stated that a cough had been present almost continuously since a cold at two weeks of age.

Physical examination revealed a reddened pharynx, dull retracted ear drums, and a few fine râles in the left apex. Breath sounds and percussion notes were normal. The rectal temperature was 102°, pulse 148, respirations 24.

The admitting diagnosis was malnutrition resulting from a persistent recurring upper respiratory infection, with the possibility of a lipid pneumonia. Fluid balance was restored and the patient put on gavage feedings. During the first week the temperature gradually came down to 100°, but the weight gain was not satisfactory and vomiting still occurred. Five days following admission, after a vomiting episode, cyanosis and intensification of a previously weak cough appeared. Loose râles were present throughout both lungs and it was thought that an aspiration of vomitus had resulted in an aspiration pneumonia. Respirations became more labored but remained between 24 and 40. Fluoroscopy on July 21 did not show a mediastinal shift and a roentgenogram revealed some hilar and peritruncal thickening, but no definite area of bronchopneumonia. On July 31, the cyanosis increased and respirations, 50 to 60 per minute, became more labored. A pharyngeal smear on Aug. 15 contained epithelial cells with cytoplasmic inclusion bodies. The patient died three days later.

Autopsy revealed distended lungs except for an area of consolidation involving three-fourths of the left upper lobe. All of the bronchi throughout both lungs contained purulent material, occluding their lumina. Microscopic sections of lung tissue were typical of the so-called virus pneumonia.

The author questions the significance of cytoplasmic inclusion bodies as an aid to diagnosis of "virus pneumonitis."

**Statistical Data. New Cases of Tuberculosis Discovered by Case-Finding Surveys.** Edited by Mary Dempsey. *Am. Rev. Tuberc.* 48: 58-63, July 1943.

From available information, it seems probable that at least 12,000,000 men will have had chest x-ray studies by the end of 1943 in connection with examination for the Armed Forces of the United States. In addition,

the U. S. Public Health Service is simultaneously conducting on an intensive case-finding campaign among employees of certain war plants, as well as those in government departments, and estimates that approximately 2,000,000 of these workers will have been x-rayed by the end of the year. Careful estimates based on actual findings to date indicate that by the end of this year (1943) approximately 25,000 persons will have been found in need of hospitalization who in ordinary times would not have been suspected of having tuberculosis. This figure indicates the need for greatly increased sanatorium facilities. In the past the ratio of two beds per annual death has been accepted as the minimum standard for determining the adequacy of hospital facilities. Comparing the number of deaths in 1941 with all available beds, it is found that only 15 states and the District of Columbia met this minimum standard. Now that case-finding surveys are being made on a nation-wide scale never before contemplated, it is obvious that facilities must be provided to care for those cases in need of treatment which are being found in an earlier stage than was previously possible. A table is appended showing the total number of additional beds needed for the various states to meet the minimum standard and care for the additional cases which will have been diagnosed. L. W. PAUL, M.D.

**Roentgenographic Surveys for Tuberculosis in Massachusetts and Their Importance to the Physician.** Philip E. Sartwell. *New England J. Med.* 228: 711-713, June 3, 1943.

In Massachusetts 2,000 men have been rejected for military service because of tuberculosis or suspected tuberculosis. Industrial organizations have also been requiring pre-employment chest roentgenograms to detect tuberculosis, and many colleges require x-ray examination of students.

In industrial surveys, conducted by the Massachusetts Department of Public Health, when a positive case is found the patient is referred to his physician, who determines the activity of the process and the necessity for sanatorium care and a search for contacts. If the case is an active one, he reports it to the Department of Health.

Serial roentgenograms are the most reliable test for determining the presence or absence of the disease in suspects and healed cases about which any doubt exists.

Primary infection is rarely seen in an active stage in adults but calcified foci are frequently defined. Pleurisy with effusion is not often found in surveys but evidence of old pleurisy may be detected. Many non-tuberculous lesions are discovered, as are also cardiac lesions, bone deformities, and diaphragmatic abnormalities.

While public and voluntary agencies have assumed an increasingly important role in tuberculosis control, the initial diagnosis must in most cases still rest with the physician. Even when case-finding surveys initiate the attack on the disease, it must be carried to completion by the individual practitioner.

JOHN B. McANENY, M.D.

**X-Raying of School Personnel.** R. R. Newell. *California & West. Med.* 59: 48-49, July 1943.

The adult "open type" of tuberculosis is the form of the disease which is most dangerous from an epidemiological standpoint. Teachers, secretarial personnel,

and janitors in the public schools comprise a group which may have open tuberculosis and constitute a source of infection for large numbers of susceptible children. Statistics show that 3 to 10 adults per 1,000 have tuberculosis of the adult type. At this rate, among 3,000 public school employees (the figure for San Francisco) between 10 and 30 potential spreaders of the disease may be expected.

The well known methods of roentgenological case finding and their comparative efficiency and cost are mentioned. A fluoroscopic survey in San Francisco's Chinatown revealed a rather high incidence of tuberculosis, but about 20 per cent of the cases were lost to follow-up. In such a group, a slightly lower efficiency may not be of first importance and may be offset by the decrease in expense. Among school personnel, however, there is little chance that any case will not be adequately followed, so that one must measure the increased cost of the more efficient method against the presumptive cost of one missed case whose continued presence in the school might easily mean the production of one or several instances of reinfection tuberculosis among the pupils.

MAURICE D. SACHS, M.D.

**X-Raying of School Personnel.** D. T. Proctor. *California & West. Med.* 59: 49-51, July 1943.

No tuberculosis program is complete unless there is a 100 per cent examination of all school personnel. Most tuberculosis associations and boards of health seem to be of the opinion that such examinations should be compulsory, but requirements differ from state to state. Most favor a chest film as the minimum essential, to be interpreted by an approved group of roentgenologists and phthisiologists.

In Los Angeles County, California, from 1939 to 1942, inclusive, 5,526 school employees were x-rayed: 122 cases (2.2 per cent) of chronic tuberculosis were diagnosed, and 12 cases (0.2 per cent) of active disease.

The author is of the opinion that, in order to protect school children from tuberculosis, all school personnel should be certified free of the disease. They should therefore be x-rayed at least once. Re-examination on negative cases need not be done oftener than every five years unless clinical findings warrant an earlier examination. Follow-up of all tuberculosis cases should be under direct supervision of the health department and all reports should be kept confidential. In order to carry out such a program, legislation, as well as the backing of organized teachers, is necessary.

MAURICE D. SACHS, M.D.

**Pulmonary Tuberculosis: Bacteriological Examinations Supplementing Routine Thoracic Radiography in the Australian Military Forces.** Reginald Webster. *M. J. Australia* 2: 61-67, July 24, 1943.

Bacteriological examinations were done on 1,548 members of the Australian Armed Forces who were suspected of pulmonary tuberculosis on the basis of radiographic evidence. The reason for this approach to the problem of tuberculosis lay in the prospect it offered of furnishing data upon which diagnosis by miniature radiography might be evaluated and also in the hope of gleanings facts regarding the number of tubercle bacillus "carriers."

The procedure followed requires the patient to report at 9 A.M. after eleven hours of fasting. If a satisfactory



sputum specimen is not obtained, a sample of the content of the fasting stomach is taken by means of a Rehfuß tube. The value of the mucus from the stomach is determined solely by the amount of bronchial mucus it contains. Not one of 59 women examined could furnish any sputum; yet there were 20 positive cultures from this group.

The routine laboratory diagnosis of tuberculosis based on cultural methods to the exclusion of animal inoculation may be criticized on the basis of the existence and occasional intrusion into cultures of acid-fast bacilli other than mammalian tubercle bacilli. Acid-fast saprophytes are often associated with butter and milk and may confuse the issue in the cultivation of tubercle bacilli from gastric contents. Past experience, however, has shown that such acid-fast saprophytes are not a serious source of error in well conducted laboratories.

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In correlating the bacteriological results in relation to the radiological estimation of activity, the recruits were divided into four groups. Those declared roentgenographically to have "active pulmonary tuberculosis" totaled 505, and of these 53.8 per cent were positive. Gastric culture accounted for 118 of these. The second group comprised those of "doubtful activity." Out of 237 such cases, 14.3 per cent were positive (21 by the gastric culture method). The third classification of "pulmonary tuberculosis, old, healed, or inactive," radiographically, included 374 cases, of which 5.6 per cent gave a positive bacteriological diagnosis. The fourth group consisted of the "doubtfully tuberculous" and totaled 224. Of these cases, 9.3 per cent were positive bacteriologically.

These findings would indicate that the activity, quiescence, or healing of a tuberculous process cannot be determined radiographically on the basis of a single film, but must be based on serial roentgenographic studies and even then there are definite limitations, which must be bolstered by bacteriological examinations.

Unfortunately, an adequate bacteriological routine for the examination of tuberculous suspects tends to cause delay, which in the case of army administration may cause serious inconvenience. Positive bacteriological findings are generally determined in an average period of twenty-one to twenty-eight days, but a negative report cannot safely be made until the culture tubes have emerged sterile from at least six weeks' incubation.

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picking up early lesions is unquestioned. The five cardinal points of Dr. Lawrason Brown should be kept in mind: (1) persistent râles in the upper half of the chest; (2) parenchymatous roentgen lesion; (3) tubercle bacilli in the sputum; (4) history of unexplained hemoptysis of a teaspoonful or more; (5) history of unexplained pleurisy with effusion.

The presence of a wheeze has been considered a sign of asthma, foreign body, or lung tumor, but it has been the experience of the author that at least in a fair number of cases it is one of the first signs of pulmonary tuberculosis. Persistent wheeze in a known tuberculous patient demands a bronchoscopic study, the main reason being that tuberculous tracheobronchitis may cause serious obstruction if left untreated. Tuberculous tracheobronchitis may precede parenchymal lesions; in a series of 28 cases, 14.2 per cent showed no roentgen evidence of involvement of the parenchyma.

In differentiating the wheeze of tuberculosis from that of asthma, we find that the tuberculous wheeze is usually well localized over the area of involvement and is fairly constant. Tuberculous bronchitis is found more commonly in women than in men by a ratio of ten to one. Seven case histories are included.

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A group of 47 tuberculous patients in whom bronchiectasis also was present forms the basis for this report. In 12 of these patients the bronchiectasis was found at autopsy. In the remaining 35, studies with iodized oil were made while patients were undergoing sanatorium treatment; of these, there were 3 in whom the bronchiectasis was felt to be independent of the tuberculous process and merely accidentally associated, while in the other 32 the bronchiectasis was considered a result of the tuberculosis. In these patients, with rare exceptions, the general appearance of the plain roentgenograms failed to demonstrate anything that might be considered unusual in ordinary chronic tuberculosis, the bronchiectatic process being masked by the tuberculous disease. Following instillation of iodized oil a moderate to marked degree of distortion and abnormal angulation of the bronchi was found in over one-half of the cases. The appearance suggested that the bronchi were being irregularly displaced out of the normal position by the pulmonary fibrosis in their vicinity. In most instances the location of the bronchiectasis and the area of major tuberculous involvement coincided. The individual cylindrical and fusiform dilatations showed nothing very unusual or different from what is seen in ordinary bronchiectasis.

It seems likely that suppurative bronchiectasis in tuberculous patients represents a specific pathological process due to tuberculosis, directly involving certain segments of the bronchial tree and differing from the benign dilatation that might be explained on the basis of pulmonary fibrosis. Once having developed, secondary changes due to the presence of pyogenic bacteria may determine the severity and the course the condition is to follow.

Bronchiectasis in tuberculosis, therefore, can be of two types. In the one it is merely a benign bronchial dilatation not associated with abnormality of bronchial function and producing few symptoms. In the other and smaller group a true suppurative bronchiectasis is

superimposed upon the tuberculosis and may overshadow the latter in its clinical aspect.

L. W. PAUL, M.D.

**Liquefaction Necrosis in Bilateral Symmetrical Conglomerate Lesions of Anthraco-Silicosis of the Lung: Report of a Case.** Bernard J. McCloskey. *Am. J. Roentgenol.* 50: 42-45, July 1943.

The case reported here was that of a 63-year-old man who had worked as a pick miner in a soft coal mine for twelve years, from 1884 to 1896. No further exposure to silica had occurred up to the time of the patient's death from gastric cancer, forty-four years later. The roentgenogram of the chest taken one month before death showed a diffuse, uniform and irregular nodulation throughout the chest, except at the extreme apices. There was a conglomerate shadow in each subclavicular area. Autopsy showed liquefaction necrosis in large conglomerate lesions of anthracosilicosis not complicated by tuberculosis. This produced cavities filled with thick, viscid, black fluid. The roentgenologic appearance of the necrotic areas was that of consolidation or pleural thickening. Examination of the cavity fluid showed no free silica. The cavity wall and surrounding lung tissue had a content of 0.25 per cent silica. The lungs showed no metastasis from the gastric cancer.

CLARENCE E. WEAVER, M.D.

**"Mitralization" of the Cardiovascular Silhouette in the Posteroanterior Roentgenogram.** Robert Shapiro. *Am. J. Roentgenol.* 50: 46-53, July 1943.

The term "mitralization," as applied to the cardiovascular silhouette in the postero-anterior projection has been widely used to indicate a straightening or convexity of the left upper heart border. In mitral stenosis the right ventricle enlarges upward and to the left, causing a straightening or even a convexity at the area of normal concavity of the left heart border. This appearance, however, is not confined to mitral stenosis. In the majority of instances, enlargement of the left auricular appendage does not seem to play an important role in the formation of the left upper heart border.

A "mitral type" of heart may be seen under certain physiological conditions. Roentgenograms taken in deep inspiration produce a pseudostraightening of the left heart border because of descent of the diaphragm. In the thin asthenic type of person with a long, narrow chest and low diaphragm, the heart may rotate in a clockwise direction so that the pulmonary artery is brought into more prominent relief; the left lower heart border takes a steeper course, and a straightening results. In many children the heart is globular, the left border being smoothly convex, giving the appearance of "mitral configuration." A prominent visible descending aorta may on casual inspection seem to produce an accentuated left upper heart border.

A variety of pathological conditions may also produce a straightening of the left heart border. Scoliosis of the dorsal spine to the right causes a rotation of the heart, bringing the pulmonary artery into more prominent relief. Change in contour of the heart also occurs as a result of funnel breast. Chronic diffuse pulmonary disease can bring about enlargement of the right side of the heart. This is probably chiefly due to resistance in the pulmonary circulation in conjunction with interference with the respiratory mechanism. Such right ventricular enlargement may occur in pneumoconiosis,

emphysema, certain types of chronic pulmonary tuberculosis, pulmonary arteriolar sclerosis, and in non-tuberculous bacterial disease. Enlarged hilar nodes and pleuropericardial adhesions may cause an appearance of straightening of the left heart border. The "mitral type heart" is sometimes seen in beriberi and hyperthyroidism.

While mitral stenosis is by far the most common pathological condition responsible for a straight upper left border of the heart shadow, it may occur, also, in association with other types of cardiac disease. Patent ductus arteriosus may give rise to enlargement of the pulmonary artery with straightening or convexity of the left upper heart border. Heart failure and pericardial effusion are other possible causes.

Because of the wide variety of conditions in which the phenomenon may occur, a roentgenologic diagnosis of mitral stenosis should rarely be made from the postero-anterior view alone; one should also have oblique views, especially the right anterior oblique view with barium paste in the esophagus to demonstrate the presence of left atrial enlargement. The roentgenologist should discard such ambiguous terms as "mitralization," "mitral type heart," "mitral configuration," etc., since they tend to be confusing and inaccurate.

CLARENCE E. WEAVER, M.D.

**Roentgenologic Diagnosis of Right-Sided Enlargement of the Heart.** M. L. Sussman, A. Grishman, and M. F. Steinberg. *New England J. Med.* 228: 777-783, June 17, 1943.

Angiocardiographic studies were made in 270 patients following intravenous injection of 70 per cent diodrast. This report is concerned with the evaluation of criteria to determine right-sided cardiac enlargement.

Emphysema is usually considered as producing right-sided hypertrophy, but of 28 cases of this condition studied, only 10 showed enlargement, and in none did this exceed 10 per cent of the accepted normal. In several cases having the greatest degree of ventricular dilatation, the cardiac configuration was normal. This is explained by the bulge of the interventricular septum to the left. The left middle cardiac contour was prominent in some cases and prominence of the hilar vessels was noted in more.

It is apparent from angiocardiographic studies that the prominent middle left arc in mitral heart disease is not due to enlargement of the pulmonary conus and artery but to enlargement of the left auricle, especially the atrium.

In cor pulmonale the heart is enlarged in its transverse diameter, mainly to the left, with a bulge of the middle left segment, which is due to dilatation with tortuosity of the pulmonary artery.

This study shows that considerable right-sided enlargement may occur before it can be demonstrated in the conventional roentgenogram. As dilatation increases, there is enlargement of the transverse diameter to the left; later, when dilatation of the right auricle occurs, there is enlargement to the right and anteriorly.

JOHN B. MCANENY, M.D.

**Dissecting Aneurysm of the Aorta.** R. Bruce Logue. *Am. J. M. Sc.* 206: 54-66, July 1943.

Dissecting aneurysm of the aorta is characterized by splitting of the media, in which cystic degeneration is frequently present. Hypertension is almost always associated, and although arteriosclerosis is invariably

## ABSTRACTS OF CURRENT LITERATURE

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sputum specimen is not obtained, a sample of the content of the fasting stomach is taken by means of a Rehfuß tube. The value of the mucus from the stomach is determined solely by the amount of bronchial mucus it contains. Not one of 59 women examined could furnish any sputum; yet there were 20 positive cultures from this group.

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tumor was excluded by excretory pyelogram. At operation, at the age of 7 weeks, a cyst 3 inches in diameter was found lying behind the transverse colon. It was attached to the inferior surface of the pylorus and first portion of the duodenum, which were stretched like a band across the cyst. The involved portion of the stomach and duodenum, bearing the cyst, was resected and an end-to-end anastomosis made. Recovery was uneventful and at six months the infant was normal in all respects. The pathological report was a developmental cyst arising as a diverticulum from the first portion of the duodenum. Microscopically the cyst wall contained all the components of the duodenum.

Nine cases of developmental enterogenous cysts arising in the duodenum were found in the literature, with 3 recoveries. With one exception, all of the patients were very young infants. One case is reported in a girl of 15 years with a long history of abdominal pain and vomiting.

These cysts are thought to originate as diverticula from the gut, the communication between the diverticulum and the intestine then becoming obliterated. The diagnosis depends on the presence of a large abdominal tumor which is unlike the small hard tumor found in hypertrophic pyloric stenosis. Successful results have been obtained from the following methods of treatment: (1) drainage of the cyst into the duodenum; (2) aspiration of the cyst followed by gastro-enterostomy; (3) resection and anastomosis.

MAX CLIMAN, M.D.

**Enlargement of the Ileocecal Valve.** Ross Golden. *Am. J. Roentgenol.* 50: 19-23, July 1943.

The ileocecal valve is rarely large enough to produce a recognizable indentation in the shadow of the barium-filled cecum. Two cases are described in which the lips of the valve were enlarged. One showed a large defect about the ileocecal junction, interpreted as suggesting slight intussusception. At operation, hypertrophy of the lips of the ileocecal valve was found with edematous mucosa covering them, causing a bulging into the cecum. The terminal ileum was edematous. The author thinks it is quite probable the edema in this case was due to a nutritional deficiency from lack of vitamins. No other cause could be found. In the second case an area of diminished density around the ileocecal valve was present on the roentgenograms. The terminal ileum was not well seen. A shadow in the cecum was thought to be a polyp. Operation showed the presence of early regional enteritis. The ileal side of the ileocecal valve was edematous and pendulous, projecting into the cecum.

The demonstration of enlargement of the ileocecal valve by barium enema may be taken as a strong suggestion to look for regional enteritis by means of a small intestine study. Pressure roentgenograms of the ileocecal junction are to be highly recommended.

CLARENCE E. WEAVER, M.D.

**Sigmoiditis.** Stephen L. Casper. *Am. J. Roentgenol.* 50: 24-31, July 1943.

Sigmoiditis is considered by the author to be a disease entity. Its incidence in a series of 489 barium enema studies was 2.6 per cent. Of the 13 patients, 11 were females and 2 males. Their age ranged from thirty-seven to seventy-five years. Spasticity and irritability of the sigmoid were obviously in excess of nor-

mal and were restricted to the distal end of the descending portion of the colon and the sigmoid. So far as is known, none of these patients has subsequently developed a more extensive or progressive colitis.

The outstanding symptom is pain, often dull and aching in character and usually limited to the lower abdomen, especially the left lower quadrant. Diarrhea or constipation may occur, either alone or alternately. The onset in several of the patients suggested disease of the urinary tract. Systemic symptoms were relatively mild. The most frequent tentative diagnosis was diverticulitis of the sigmoid. Uniform reduction in the caliber of the sigmoid, as well as shortening of this segment of the colon, may be a sequel to the disease.

Conditions to be differentiated are diverticulitis of the sigmoid, sigmoiditis secondary to pelvic inflammatory disease, inflammatory changes secondary to radiation therapy, endometrial implants, syphilitic involvement of the colon, chronic ulcerative colitis, tuberculosis, lymphogranuloma venereum, and cancer.

In the examination by barium enema roentgenoscopy is of paramount importance. The barium suspension is permitted to flow while the patient is placed in the supine and various oblique and lateral positions. It is preferable to make exposures while the opaque medium is still flowing. The enema should be given slowly and interrupted at intervals. While the flow may be retarded due to irritability, there is no obstruction. None of the cases showed any indication of mucosal ulceration.

Treatment consists of a low-residue diet, hot rectal irrigations of physiologic saline solution, and thorough atropinization with tincture of belladonna.

Case reports illustrated by roentgenograms are given.

CLARENCE E. WEAVER, M.D.

**Lateral View in the Roentgenologic Diagnosis of Lesions of the Colon.** Egon G. Wissing and Robert M. Lowman. *New England J. Med.* 229: 207-210, July 29, 1943.

This is a plea for more extensive investigation of the colon by all means at one's command. There is full acknowledgment of prior advocacy of all the procedures described, but the need for their use is again emphasized.

The difficulty of defining a sigmoid lesion in the routine postero-anterior view is stressed, and the oblique and lateral exposures are advocated to demonstrate these areas more clearly in an attempt to eliminate the so-called blind-spot of the colon.

The authors advocate thorough preparation of the patient with 60 c.c. of castor oil and an evening colonic irrigation the day before examination and an enema on the morning of examination.

The barium enema is given under fluoroscopic control, with spot films as required. Postero-anterior and lateral views are then made. After evacuation, the patient is again studied fluoroscopically, air is injected if necessary, and again postero-anterior and lateral views of the colon are made.

Three illustrative case histories are presented with their roentgenographic demonstration.

JOHN B. McANENY, M.D.

**Intussusception of the Appendix.** Kenneth Fraser. *Brit. J. Surg.* 31: 23-33, July 1943.

Seventy-five cases of intussusception of the appendix are reviewed and 7 new cases are reported. Various

theories are offered to explain the development of this rare condition. Excessive peristalsis to extrude a concretion or polyp is considered a factor in a number of instances. Two-thirds of the cases occur in children due to increased lymphoid tissue in the terminal ileum and appendix. The lymphoid tissue acts as a foreign body and gives rise to irregular and increased peristalsis of bowel and appendix, sometimes culminating in intussusception. Other cases seem to be attributable to a nodule of inflammatory tissue developing at the base of the appendix, causing a buckling inward first of the mucosa and later of all its coats at the point of involvement. In a certain proportion of the cases it is probable that the intussusception has been preceded by an acute attack of appendicitis, which has left a thickening of the appendiceal wall at or near its base, so localized as to give rise to the foreign-body effect necessary to the onset of vigorous appendiceal peristalsis. Several cases of intussusception of the appendiceal stump have been reported following appendectomy and inversion of the stump.

Intussusception of the appendix into itself occurred only twice in the entire series considered by the author. In the vast majority of instances the process starts at the junction of the appendix with the cecum, so that the intussusception is formed by the base of the appendix prolapsing into the cecum. In a third of the cases the intussusception progressed and reached the ascending colon or further.

The clinical features in a simple intussusception are severe colicky pain in the mid-abdomen, and sometimes in the right iliac fossa, lasting a few minutes and followed by periods of complete well-being. Vomiting occurred in many cases; it was a more obvious feature in the compound type of intussusception with invagination of the ileocecal valve into the ascending or transverse colon or beyond. In the absence of rigidity of the abdomen a mass was frequently palpable in the right iliac fossa, slightly tender and usually mobile. X-ray examination may be of diagnostic value. A barium enema may reveal a filling defect in the cecum or failure of the cecum to fill.

Several possible lines of treatment are considered, suitable to the different types of intussusception encountered. Illustrations are included.

MAX CLIMAN, M.D.

### THE BILIARY TRACT

**Cholecystography: Correlation of the Roentgenological, Surgical, and Medical Findings in 355 Cases.** Henry J. Walton and Charles N. Davidson. *Southern M. J.* 36: 411-414, June 1943.

This paper presents a comprehensive study of the accuracy of cholecystographic interpretation. The findings of the authors in a series of 355 examinations are in close agreement with other published reports of large series of cases. Observers agree that a non-demonstrable gallbladder is diseased in well over 90 per cent of all cases and that extrabiliary factors in non-visualization are negligible.

Of the 355 cases reviewed here, 100 were subjected to surgery and the roentgenological, surgical, and pathological findings were correlated. The remaining 255 cases were treated medically, with similar correlation of biliary disease as found clinically and gallbladder function as observed roentgenologically. Oral cholecystography was the method generally employed.

In the surgical group the roentgenological findings were confirmed in 91 cases. Of 56 patients in whom visualization could not be obtained, 53 had unquestionable gallbladder disease; of 22 in whom function was found roentgenologically to be poor, 20 had gallbladder disease, confirmed pathologically; while of 22 in whom function was found unimpaired, 18 had normal gallbladders.

In the medically treated group, 88.7 per cent of the cholecystographic findings were corroborated by a clinical diagnosis of cholecystic disease. Of the 255 patients, 185 had normally functioning gallbladders, 44 had poorly functioning gallbladders, and 26 had non-functioning gallbladders. Of the 185 reported as having normal function, 163 had no clinical evidence of biliary disease, 6 had a definite diagnosis of biliary disease, 9 had a diagnosis of possible biliary disease, and 7 had a final diagnosis of catarrhal jaundice. Of the 44 patients with poorly functioning gallbladders, 34 had diagnoses of gallbladder disease, 2 had a possible diagnosis of gallbladder disease, 5 had no diagnosis referable to the biliary tract, 2 had cirrhosis of the liver, and 1 catarrhal jaundice.

In the 26 cases with a report of non-functioning gallbladders a diagnosis of cholecystitis was made in 21 instances. The remaining 5 cases were diagnosed as cirrhosis of the liver, catarrhal jaundice, cholangitis, syphilitic hepatitis, and acute hepatitis.

MAX MASS, M.D.

### THE SPLEEN

**Single True Cysts of the Spleen: Report of 3 Cases.** Richard H. Sweet. *New England J. Med.* 228: 705-710, June 3, 1943.

Cysts of the spleen are classified as true and false. True cysts comprise about 21 per cent of the total and are distinguished from the false cysts by being lined by a specific secreting membrane. Three complete case reports of true cysts are presented.

The diagnosis is not too difficult. There is a large left upper quadrant abdominal tumor, raising the left costal margin and showing a resilient quality on palpation and usually a detectable fluid wave. The roentgen picture is characteristic. The large abdominal tumor raises the left half of the diaphragm, which shows impaired motion. The lower pole of the mass has a somewhat pointed or angular contour and may extend into the pelvis. The stomach is displaced to the right and possibly posteriorly. The colon is displaced inferiorly and to the right. The left kidney is displaced downward. The combination of the physical and roentgen observations is sufficiently characteristic to be diagnostic.

Treatment is by splenectomy. It is surprising how rapidly the displaced organs return to normal after the tumor is removed.

JOHN B. McANENY, M.D.

### THE SKELETAL SYSTEM

**Evolution of the Circulation in the Developing Femoral Head and Neck: An Anatomic Study.** W. Eugene Wolcott. *Surg., Gynec. & Obst.* 77: 61-68, July 1943.

The author summarizes his earlier studies of the circulation in the adult femoral head and neck as follows:

1. The ligamentum teres carries at least one main artery which penetrates the head of the femur and

anastomoses with vessels entering the head by way of the visceral capsule in approximately 80 per cent of adult specimens.

2. In about 20 per cent of adult specimens the ligamentum teres vessels failed entirely to enter the femoral head.

3. The uniformity of size and area of distribution of vessels within the femoral head led to the conclusion that it was adequate to nourish a greater portion of the head of the femur in cases in which the artery actually penetrated the substance of the head.

4. The visceral capsule never failed to carry two groups of arteries, usually three to four in number, which entered the neck of the femur just distal to the subcapital area, traveling directly toward the center of the femoral head, where they anastomosed with the terminal branches of the nutrient artery of the shaft and the ligamentum teres vessels. These two groups of arteries lie within the superior posterior quadrant and inferior posterior quadrant of the visceral capsule. The anterior portion of the visceral capsule contains no arteries of importance. The capsular arteries are the major source of blood going to the head and neck of the femur and arise from the median circumflex artery.

5. A small branch of the posterior circumflex artery also sends branches into the ligamentum teres.

6. These studies failed to demonstrate vessels entering the substance of the head by way of the ligamentum teres in specimens from infants and children under ten years of age. It was this observation which prompted the present study.

The author reviews the literature, which shows the controversy which has existed as to the importance of the various sources of arterial blood supply. While some authorities attach greatest importance to the vessels running through the ligamentum teres, others consider the vessels of the visceral capsule of the first significance.

The author's experiments with animals confirmed work reported by Cella which showed that in a developing animal the major proportion of nourishment to the growth center in the head of the femur is supplied by the capsular vessels. A number of human specimens of varying ages were also successfully injected (photographs of the injected specimens are included), as the result of which the following conclusions were reached:

1. The ossifying center in the developing head of the femur in infants and children receives its blood supply from the visceral capsule vessels which arise from the median circumflex artery.

2. The ligamentum teres vessels do not enter the head of the femur in children nor do they contribute to the nourishment of the growing femoral head except for very small vessels which accompany the fibrous tissue at the implantation of the ligamentum teres into the fovea area.

3. The anastomosis between the ligamentum teres vessels, the capsular arteries, and the nutrient artery of the shaft does not take place until the ossification of the head of the femur is practically, if not entirely, complete, at which time the vessels of the three systems unite by penetrating the thinned-out cartilage area at the fovea, thus establishing the anastomosis.

4. The ligamentum teres circulation is a closed circulation, in so far as the femoral head is concerned, until such an anastomosis takes place.

ELLIS C. OSGOOD, M.D.

**Delayed Ossification of the Temporal Bone.** Hans Brummer and H. James Hara. *Ann. Otol., Rhin. & Laryng.* 52: 444-459, June 1943.

A five-month-old child had an acute otitis media and a right postauricular swelling. A right antrotomy was performed, and six days later the patient was admitted to the hospital with acute suppurative meningitis, which proved fatal.

The autopsy findings are presented in great detail. Chief features of interest were (1) the presence of areas of atypical epithelium in the membranous inner ear, indicating a developmental disturbance; (2) changes in the bony capsule of the inner ear and the ossicles; (3) meningitis invading the inner ear along the auditory meatus and the cochlear aqueduct.

The bony abnormalities were most pronounced in the periosteal layer, the greater portion of which consisted of a large marrow space containing hyperemic capillaries and lymphoid marrow. In the region of the cochlea the marrow space was separated toward the endochondral layer as well as toward the dura by a relatively thin layer of periosteal bone. Neither osteogenesis nor osteoclasts was observed along the margin of the marrow space. Within the marrow were a few spicules of bone, but these did not form a network, and some of them contained a core of calcified connective tissue—a picture usually seen in younger infants (two or three months).

Most striking were the findings in the area of the semicircular canals. Though normally in a child of five months the area between the canals is largely filled with periosteal bone, it was occupied here by lymphoid marrow. The periosteal marrow contained osteoblasts only occasionally, osteoid substance rarely, and osteoclasts never. This also is in contrast to the periosteal layer in a normal child of the same age, in which the small marrow spaces contain not only connective tissue and capillaries, but also osteoblasts, osteoid substance, and occasional osteoclasts.

There was evidence of delayed osseous formation, also, in the endochondral capsule, though to a less degree.

The authors believe that these bony abnormalities represent not a simple variation of ossification, but rather a retardation due to a pathological condition. The delay in bony development exceeded physiological limits and the process of ossification was irregular and incomplete, failing to follow the normal pattern. The destruction of cartilage prevailed over the formation of bony spicules engulfing the cartilage in the center of the marrow space. The picture was characteristic of osteogenesis imperfecta congenita, but obvious alterations in the rest of the skeleton, invariably described in reports of that disease, were not present. Whether the findings represented the earliest signs of an osteogenesis imperfecta tarda, or osteopsathyrosis, cannot be definitely stated. There was no history of blue sclera, brittle bones, or otosclerosis either in the patient or the family, and whether these might eventually have developed cannot be predicted in the absence of complete examination of the skeleton.

STEPHEN N. TAGER, M.D.

**Etiology of the Undescended Scapula and Related Syndromes.** D. Engel. *J. Bone & Joint Surg.* 25: 613-625, July 1943.

This presentation is an attempt to define the cause of undescended scapula and to unite several other condi-

tions under the same causative agent. This single causative agent is believed to be a "bleb," and the theory is known as the "bleb theory."

This theory is outlined as follows: There is an area membranacea at the roof of the fourth ventricle through which cerebrospinal fluid escapes to form the subarachnoid space. If for some reason the area membranacea remains unduly patent, cerebrospinal fluid escapes into the subcutis of the adjacent neck region. This subcutaneous bleb causes failure of descent of the scapula because of the inflammatory reaction it initiates.

Experimentally, manifold deformities have been caused by bleb formation in animals. These blebs were produced by irradiation of the mother's ovaries, and the same deformities were passed on to subsequent generations of animals. The damage done by the bleb depends upon the time in the life of the embryo that it appears and its progression.

That the undescended scapula is due to bleb formation is seen from the fact that it is one of the signs of dysostosis multiplex, which belongs to the bleb disease group. If the bleb originating in the neck descends anteriorly, it exerts its greatest pressure at the end of the limb bud, resulting in the deformity known as symbrachydactylia. If the bleb remains on the posterior neck surface and fails to migrate, the Klippel-Feil syndrome develops. If the bleb progresses distally, somewhat, the undescended scapula deformity results.

JOHN B. McANENY, M.D.

**Congenital Retardation in Development of the Carpal Navicular, First Metacarpal, and Styloid Process of the Radius.** A. R. Hodgson. *Brit. J. Surg.* 31: 95-96, July 1943.

A female, aged 29 years, had always suffered from weakness of the wrists, especially the left. Examination revealed atrophy of the left thumb, hand, wrist, and distal part of the forearm. The thumb was adducted along the index finger; full abduction was about 20 degrees from the long axis of the ulna. The scaphoid could not be felt on palpation with the hand in full ulnar deviation. The power of grip was one-eighth of normal.

Roentgenograms showed a tiny rudimentary navicular measuring 0.5 cm. by 0.25 cm. The distal end of the bone had a fairly round clear-cut edge and the proximal end had an indistinct margin. There were complete absence of the styloid and some shortening compared with the ulna at the radio-ulnar joint. The proximal end of the first metacarpal had no tubercle for the insertion of the abductor pollicis longus.

In the right hand these same deformities were present, but in less degree.

MAX CLIMAN, M.D.

**Osteogenesis Imperfecta.** James F. Brailsford. *Brit. J. Radiol.* 16: 129-136, May 1943.

Osteogenesis imperfecta is believed to be a severe form of the dystrophy variously called idiopathic osteopsathyrosis, fragilitas ossium, and hereditary fragility of bone. These designations should be dropped and the term osteogenesis imperfecta be extended to include the fetal, infantile, adolescent, and adult types of the disorder.

This dystrophy has a familial distribution, and the affected members usually show, in addition to the bone changes, blue sclerotics. Deafness is sometimes associated.

In the fetal form the bones have a thin cortex. The internal structure is granular, indicating a calcification rather than ossification. The infantile type is frequently characterized by small, multiple, rounded, bony, cell-like structures, enclosing non-osseous tissue, particularly in the epiphyses. These are similar to the rounded cartilaginous structures seen in ecchondroses. In the adult and adolescent types the long bones have slender shafts composed almost entirely of compact bone while the expanded extremities are of coarse cancellous tissue; deformities of the ribs and pelvis are common.

The skull exhibits a considerable variation in the degree of involvement. In infancy it usually appears thin and ballooned. As the child grows it seems to settle down over the base, producing a tam-o'-shanter appearance. The vertebral bodies show more or less compression. Fractures are common.

Nine cases are presented in detail.

SYDNEY J. HAWLEY, M.D.

**Osteopathia Condensans Disseminata Associated with Coarctation of the Aorta: Case Report.** George S. Phalen and Ralph K. Ghormley. *J. Bone & Joint Surg.* 25: 693-700, July 1943.

This is a case report of a patient who had twisted her left ankle. Roentgenograms showed sclerosis of all the bones of this region. Further roentgen study revealed osteopetrosis of the entire left lower extremity and the right humerus. Other bones showed small areas of bone condensation which were believed to represent osteopoikilosis. An associated coarctation of the aorta was indicated by notching in the lower rib margins.

JOHN B. McANENY, M.D.

**Gargoylism: Report of Three Probable Cases.** Sidney Larson and John A. Lichty, Jr. *Am. J. Roentgenol.* 50: 61-66, July 1943.

In gargoylism the head is usually large and the neck short. The nasal bridge is flat and broad. The lips may be thick and the tongue protruding. Dentition may be delayed. There may be, also, mental retardation, corneal clouding, and enlargement of the liver and spleen. The abdomen is protuberant. The legs and arms are relatively short, the joints held in semiflexion; the hands are short and broad, and there is a lumbo-dorsal kyphosis. Other clinical features are mucopurulent rhinorrhea, recurrent otorrhea, deafness, poorly developed muscles, hypertrichosis, retarded sexual development, and leathery skin. Morquio's disease offers the greatest problem in differential diagnosis, but mental retardation is not present in that condition, the skull shows no abnormalities, and the vertebral deformity is not the same.

Abnormal findings in the skull are a constant feature of gargoylism. The cranium is enlarged and frequently there is hydrocephalus. Abnormal shapes are common. Sellar changes are not constant. The ribs may be markedly broadened and the scapulae are often high in position. The spine is involved in a peculiar kyphosis of the dorsolumbar region. This kyphosis is the most constant osseous change. The bones of the extremities are thickened. The humeral and femoral heads may be irregular and flattened. Retarded carpal ossification is not uncommon.

The term "gargoylism" is noncommittal in etiological implication. The term "lipochondrodystrophy"



suggests the association of the disease with the lipoidoses. Washington (in *Practice of Pediatrics*, edited by J. Brennenman, Hagerstown, Md., W. E. Prior Co., Vol. IV, Chapter XXX) studied 6 cases postmortem. The salient histologic feature in these cases was the degenerative change in the nerve cells of the central nervous system. The cytoplasmic lipoid deposits found were most pronounced in the basal ganglia and the brain stem. Lipoid infiltration has been identified in liver, spleen, lymph nodes, lungs, heart, and thymus, but not in the bones.

The authors describe in detail three cases exhibiting some of the features characteristic of this disease.

CLARENCE E. WEAVER, M.D.

**Osteochondritis Dissecans. Records of Some Unusual Cases.** Robert G. Hutchison. *Brit. J. Radiol.* 16: 147-149, May 1943.

By way of emphasizing the occurrence of osteochondritis dissecans in sites other than the typical one in the knee, 7 cases are put on record, 3 involving atypical sites in the knee, 2 involving the ankle, 1 the phalanx of a toe, and 1 the head of a metacarpal bone.

**Multiple Spontaneous Idiopathic Symmetrical Fractures: Milkman's Syndrome.** Louis Edeiken and Norman G. Schneeberg. *J. A. M. A.* 122: 865-870, July 24, 1943.

Milkman's syndrome is a very rare skeletal osteopathy appearing mainly in middle-aged women and consisting of multiple spontaneous idiopathic pseudo-fractures. A review of the 19 other cases reported in the medical literature, in addition to information gleaned from their own patient, leads the authors to conclude that, although the clinical picture of this abnormality almost invariably conforms to a readily recognizable pattern, final diagnosis must necessarily be made by the roentgenologist.

The outstanding roentgenographic features are fairly symmetrical focal osteoporotic areas which progress to form translucent bands of intense local decalcification. These spread in a transverse fashion until eventually a complete transverse solution of bone continuity resembling a fracture may be produced. Early no deformity is present, but later, separation, displacement, and overriding of fragments may occur. Settling of the vertebral column, formation of a heart-shaped pelvis, coxa vara, rib, ulnar, and clavicular angulation may also appear in time. Ordinarily there is no callus formation.

Treatment of this condition has not been entirely satisfactory. Several reported cures have resulted from treatment with calcium, vitamin D, arsenicals, and vitamin A.

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**Paralytic Scoliosis.** Aladár Farkas. *J. Bone & Joint Surg.* 25: 581-612, July 1943.

This is an extensive study of the spinal curvature developing after infantile paralysis. Within a few weeks or months following the onset of paralysis a definite entity, known as the paralytic spine, is recognized from morphological and functional signs. The morphological signs are enlargement of the intervertebral spaces, which become dull and cloudy; early and irregular ossification of the epiphyseal ring; calcium

deposits in the intervertebral spaces. General bone atrophy may last for several years and heal spontaneously. The functional signs include a high degree of flexibility and compressibility. Unvertebral or segmental rotation, without lateral deviation, occurs early. Forward or backward tilting may take place, with loss of the normal lordosis and kyphosis.

The paralytic spine precedes paralytic scoliosis by several years, during which interval the convexity and direction of the rotation may change several times.

Rotation results from faulty mechanics of (1) the pelvis, (2) the thorax and shoulder girdle, and (3) respiration. In pelvic rotation all the spinous processes point to the same side of the body. In thoracic rotation the thoracic and lumbar spinous processes point in opposite directions.

The various curvatures are demonstrated by numerous reproductions of roentgenograms.

JOHN B. McANENY, M.D.

**Differential Diagnosis of Spinal Arthritis in Young Subjects.** C. W. Buckley. *Brit. M. J.* 2: 4-6, July 3, 1943.

The author points out the difficulty of the diagnostic problem of spinal arthritis in young people and emphasizes the importance of this condition due to rapid progress in the more serious form.

The typical disease known as adolescent spondylitis first manifests itself by vague back pains, pains in the limbs, and eventual flattening of the lumbar curve. This is followed by synovitis, hyperemia of the apophyseal joints of the lumbar spine and the sacroiliac joints, and thereafter similar involvement of all joints concentrically. Spinal disks do not become thin but may even expand, and complete ankylosis is the eventual result from surrounding calcification. The smaller joints may be spared. One distinguishing characteristic lies in the response to gold therapy. The latter seems to have a valuable effect in the form of arthritis which attacks older people but is of no help in adolescents.

Considerable emphasis is placed on the adolescent sacroiliac joint syndrome. A large percentage of victims are tuberculin-sensitive. It is pointed out that x-ray examinations should be made in a three-quarter lateral position in order to show the apophyseal joints. A loss of density in the articular processes, with a blurring of the joint outlines is among the earliest roentgen signs. The treatment consists mainly of rest, diet, and heliotherapy.

Q. B. CORAY, M.D.

**Ankylosing Spondylarthritis: Marie-Strümpell Arthritis. Roentgen and Orthopedic Therapy.** Lenox D. Baker. *Southern M. J.* 36: 180-184, March 1943.

Rhizomelic spondylitis, Marie-Strümpell arthritis, or von Bechterew's disease is a malady of the spine and root joints of unknown etiology. Early diagnosis of this condition is occasionally overlooked by qualified roentgenologists. Decalcification and mottled trabeculation can usually be demonstrated in the subchondral regions of the sacroiliac joints, with haziness and apparent widening of the joint spaces. Associated with these changes are focal areas of increased density. These findings may be unilateral or bilateral and are usually present before the spinal lesions become evident. Later there is a sclerosis of the subchondral area with destruction of the articular cartilage and osseous bridging of the joint space. Ankylosing ossifications



in this condition, so-called "syndesmophytes," should be differentiated from the non-ankylosing osteophytes. The former appear at first as wooly shadows which later become dense, linear, and clear cut, without a cortex. The osteophyte has a thicker base, is covered with a cortex, and contains cancellous bone.

The author cites Swaim's report (J. Bone & Joint Surg. 21: 983, 1939) on the orthopedic treatment of the disease and that of Smyth, Freyberg, and Lampe (J. A. M. A. 117: 826, 1941) on roentgen therapy of rheumatoid arthritis of the spine. He then proceeds to a description of the régime used in his institution (Duke University), which combines orthopedic and roentgen treatment. Roentgen therapy is given over the entire spine or the involved area, depending on the clinical findings. Two hundred kilovolts are used in treating fields about  $5 \times 15$  cm., 150 r being given over one or more areas daily for three to five treatments. If necessary, the dosage is repeated after three to six weeks. Roentgen-ray therapy gives early alleviation of pain with relief of muscle spasm and allows rapid correction of deformities and more vigorous attempts at restoration of muscle balance. The orthopedic measures include hyperextension of the spine, traction when this is necessary to correct flexion deformities of the hips, corrective exercises, and application of a specially designed brace, which is described and illustrated.

Satisfactory correction of deformities in the Marie-Strümpell group of patients frequently requires many weeks of hospitalization with the patient recumbent on a Bradford frame. Since the introduction of roentgen therapy the average time for correction with the combined therapies has been reduced to ten days and hospital stay to two weeks, though a longer period of hospitalization may be advisable for continued physical therapy and further supervised muscle training.

Too short a time has elapsed to determine whether the roentgen therapy is only analgesic or whether it has a deterrent effect on the disease and serves to prevent further ossification of the ligamentous structures of the spine. The fact that it has been followed by a reduction in sedimentation rate is a hopeful sign.

MAX MASS, M.D.

**Herniation of the Nucleus Pulposus as a Complication of Pre-Existing Low Back Instability.** Edwin M. Deery. Surg., Gynec. & Obst. 77: 79-86 July 1943.

The author classifies cases of herniated nucleus pulposus into two groups. The first is characterized by sciatic pain with a minimum of low back discomfort and no preceding history of "back trouble." It is in these patients that removal of the herniated nucleus alone is required. In the second group of cases herniation of the nucleus is superimposed on low back instability and in these cases fusion may be necessary.

In the author's experience a careful neurologic examination will in most instances accurately indicate the presence of a herniated nucleus as well as its level, without recourse to lipiodol.

A distinction is drawn between sciatic pain, about which the patient complains, and sciatic neuritis, a condition which produces objective neurologic changes, such as absence of the ankle jerk.

The diagnosis of herniated nucleus is made on the basis of a history of sciatic pain, with or without low back pain. There may be a limp, a loss of the normal lumbar lordosis, and postural deformities of the lumbar

spine. The neurologic signs are definite and consist of weakness of dorsiflexion of the foot, muscle atrophy and reduced or absent ankle jerk, and sensory changes along the outer side of the lower leg and foot. The author does not believe that the overlapping of the sensory distribution in the lower leg negates the clinical experiences which show a correlation between the distribution of the neurologic changes and the location of the herniation. If the sensory changes are limited to the outer side of the lower leg and ankle and foot, the herniated nucleus will generally be found in the lumbosacral interspace. If, in addition, there are sensory losses on the inner side of the foot from toe to heel the nucleus will be found in the 4th-5th lumbar interspace. Straight leg raising is limited on the painful side. The author attaches little importance to the x-ray survey of the lumbosacral region. Lumbar puncture is advocated to rule out spinal cord tumor, as well as to assist with the diagnosis of herniated nucleus, in which condition there are usually normal manometric findings but an elevation of the spinal fluid protein.

The author, as mentioned above, does not advise the use of lipiodol. He has not found it necessary and believes it may be harmful if left in the spinal canal. Its removal is often so incomplete as to be unreliable. Air myelography is considered unsatisfactory.

In the author's clinic operations for nucleus pulposus and fusion operations for an unstable back are carried out at the same time. The mortality in 100 cases was zero. The offending herniation is exposed and removed through the interlaminar space with sacrifice of little or no bone.

Herniated nuclei are of three types, Type I is the small, round, oval mass covered by the overlying lateral portion of the posterior longitudinal ligament. The mass has a rubbery resistance and is overlaid by the spinal dura and the involved nerve root. The author advocates retracting the nerve root medially, which exposes the lesion well, after which it may be removed with clamps, forceps, or curette. Type II is less common. It is a type in which the nucleus has already forced its way partly or wholly through the posterior longitudinal ligament. It lies directly under the nerve root almost free within the spinal canal. This type is readily picked up and removed in one piece. Type III is the least common. This small, almost flat lesion is often missed and by some is considered not a herniation at all. The author, however, believes that removal is indicated in such cases. Following removal of the herniated nucleus, any thickened ligamentum flavum tissue which is present should be curetted out in order to make sure that the intervertebral foramen is not obstructed.

The author does not consider sciatic pain alone convincing proof of the presence of a herniated nucleus; it may be due to a low back instability which is readily relieved by orthopedic measures. Symptoms due to herniated nucleus are not relieved by fusion operation alone in his experience, and certainly not by fasciotomy.

ELLIS C. OSGOOD, M.D.

**Posterior Hernia of the Knee (Baker's Cyst, Popliteal Cyst, Semimembranosus Bursitis, Medial Gastrocnemius Bursitis and Popliteal Bursitis).** Henry W. Meyerding and Robert E. VanDemark. J. A. M. A. 122: 858-861, July 24, 1943.

Baker's cyst is a popliteal cyst which occurs as the result of (1) herniation of the synovial membrane

through the posterior part of the capsule or (2) the escape of fluid through the normal anatomic connections of the knee joint into the bursae. Basing their article on a series of 15 cases, the authors discuss the etiological factors predisposing to the development of these lesions, their preoperative diagnosis, and the surgical treatment which offers the best prognosis.

Patients with Baker's cyst, which incidentally is almost always unilateral, generally complain of aching and stiffness of the knee and a tumor, the bulk of which is usually distal to the flexion crease of the knee. Transillumination reveals the uniform cystic character of the lesion and aspiration demonstrates the fluid contents.

Connection of the cyst with the joint can be demonstrated roentgenographically. After injection of 100 to 150 c.c. of air into the knee, the roentgenogram will often reveal an air bubble in the hernial sac. This procedure is not recommended as a routine measure because of the potential dangers of pulmonary embolism and sepsis.

Baker's cyst is to be differentiated from lipoma, fibrosarcoma, hemangioma, aneurysm, arteriovenous fistula, pyogenic or tuberculous abscess, popliteal lymphadenopathy, Charcot's joint, and varicose veins.

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**Fractures of the Neck of the Metacarpal.** Irving Redler. *J. Bone & Joint Surg.* 25: 670-674, July 1943.

Permanent deformity and disability frequently follow treatment of fractures of the neck of the metacarpal by traction methods. The author reports good results in 22 cases with the method of Jahss.

The procedure consists in breaking up the impaction, by direct manipulation, and traction correction of overriding. A plaster cast is applied to the forearm, wrist, and hand as far as the fracture site, with the wrist in slight extension. When the plaster is thoroughly set, the injured finger is flexed to 90 degrees at the metacarpophalangeal joint and proximal interphalangeal joint, with the distal interphalangeal joint remaining in extension. In this position the finger points toward the scaphoid tubercle. The injured finger is fixed in this position by a thin strip of plaster and incorporated in the cast, being pressed dorsally to correct the deformity and held in this position until the plaster sets. Immobilization is maintained for three weeks. After removal of the cast, joint motion returns very quickly, as a rule.

JOHN B. McANENY, M.D.

**Pin Distraction as the Cause of Non-Union.** Arthur G. Davis. *J. Bone & Joint Surg.* 25: 631-643, July 1943.

The occurrence of 6 cases of non-union of the lower tibia within a period of nine months focused the author's attention on this problem. All cases had been treated by pin distraction, with failure of callus formation and union to occur within a reasonable period of time. Serial roentgenograms demonstrated the non-union and distraction.

All 6 cases were subjected to bone-grafting procedures, with firm union taking place in from three to six months, showing that the potentiality for callus formation was present but that it was hindered from coming into action. Distraction is believed to be the cause in each case.

Many writers have advised caution in the use of mechanical methods to obtain reduction in fractures where one or both fragments is pulled by means of pins in the bone. It is believed that no reasonable manual or weighted pull on a fragment is capable of tearing the periosteum completely at the fracture site, but that with the pin traction sufficient force can be applied to produce a complete tear of the periosteum around the circumference of the bone.

This word of caution as to distraction of fractures as a potent cause of non-union should be seriously considered by both radiologists and surgeons.

JOHN B. McANENY, M.D.

**Plasmocytosis of the Bone-Marrow Associated with Metastatic Carcinomatosis.** E. Miller. *South African M. J.* 17: 61-63, Feb. 27, 1943.

A case of plasmocytosis of the bone marrow associated with metastatic carcinomatosis of bone is described in detail. The patient, aged 56 years, had painful swellings of the skull and sternum, which had been present for three months and had been gradually increasing in size. He also complained of loss of weight, anorexia, and malaise. The larger skull tumor, measuring about 3 inches in diameter, was fairly hard in consistency, although small areas were soft and fluctuating. The tumor was attached to the bone, but not to the skin; it was not warm to the touch. Just anterior to it was a similar tumor. A third tumor, about 1.5 inches in diameter, was attached to the body of the sternum at the level of the fifth costal cartilage. No other significant findings were noted on physical examination.

An x-ray study of the skull showed multiple large and small areas of erosion in the vault. Filling the largest gap in the vault and extruding from it was a tumor. Small particles of bone could be seen in this tumor, probably fragments of skull.

A blood count showed hemoglobin 30 per cent; red blood cells 2,000,000; white blood cells 15,000, with a high proportion of polymorphonuclear cells. No immature cells of the granular series, normoblasts, or plasma cells were seen. Examination of the bone marrow revealed a high proportion (6.5 per cent) of cells of the plasmocyte series.

Permission to perform a complete necropsy could not be obtained, but small sections of the skull and sternal tumors removed for examination showed adenocarcinoma, which was believed to be of prostatic origin.

Notes on the literature regarding the plasma cell are given.

**Solitary Eosinophilic Granuloma: Report of a Case.** Graham A. Kernwein and Frank B. Queen. *Surgery* 14: 105-110, July 1943.

Solitary eosinophilic granuloma is an uncommon benign destructive bone lesion of which, according to the authors, only 19 cases have appeared in the medical literature. Although the microscopic pathologic picture is characteristic, the pathogenesis has not been established. [The authors are not in agreement with certain observers (see for example, Gross and Jacox: *Am. J. M. Sc.* 203: 673, 1942. *Abst. in Radiology* 40: 215, 1943) that the condition is identical with Schüller-Christian disease.]

In the case here recorded the patient, a white male, 20 years of age, complained of increasingly severe pain in his right groin. Roentgen studies of the pelvis and

left hip showed an irregular region of decreased density at the upper end of the femur, mesial and inferior to the lesser trochanter. Films of the leg in internal rotation showed a thin strip of periosteal new bone. No lesions were found in the chest or in the remainder of the skeleton. A biopsy specimen was removed from the femur and a diagnosis of solitary eosinophilic granuloma was made. One week later the wound was reopened and marrow from the upper third of the femur was removed. The postoperative course was uneventful, and twenty-eight months later the patient was well and the operative defect was largely replaced with new bone.

Filling the marrow cavity in this case was a compact fibrous type of granulation tissue containing isolated, well encapsulated granulomas. Numerous eosinophilic polymorphonuclear leukocytes arranged in sheets and cords with very little supporting stroma were the most conspicuous feature of these granulomas. Interspersed throughout were numerous large polygonal cells with abundant pale cytoplasm and poorly outlined cell membrane. They contained large oval or kidney-shaped nuclei with occasional mitotic figures. In older lesions many of these cells had fused to form multinucleated giant cells. Phagocytized eosinophilic leukocytes were present in some; in others the cytoplasm appeared vacuolated. Although most of the bony trabeculae had been destroyed, some newly formed bone was present on the surface of the few remaining spicules. There were no areas of necrosis.

J. E. WHITELEATHER, M.D.

## GYNECOLOGY AND OBSTETRICS

**Combined X-Ray and External Pelvimetry.** Daniel J. McSweeney and Albert M. Moloney. *Am. J. Obst. & Gynec.* 46: 102-109, July 1943.

X-ray pelvimetry should supplement and not supplant external pelvimetry and clinical examination of the pelvis. The authors' method of investigation for cephalopelvic disproportion, preferably done within two weeks of the expected date of confinement, or better at the onset of labor, consists of (1) external pelvimetry, (2) estimation of fetal head size, and (3) x-ray pelvimetry if indicated.

The following criteria determine the need for x-ray pelvimetry:

1. Floating heads at term, in primiparas.
2. History of previous difficult deliveries.
3. Breech presentations in primiparas with apparently small pelvis by external measurements.
4. Narrow subpubic arches and outlets.
5. External conjugates of 18.5 cm. or less, in elderly primiparas.

The technic is described as follows: "We take a film directly through the pelvic inlet with the patient semi-recumbent to get a good view of the contour of the inlet. The inlet is then classified according to the classification of Caldwell and Moloy. A true lateral film is then taken on which we measure the conjugate vera, the anterior sagittal, posterior sagittal, and anteroposterior diameters of the midpelvis, the pubotuberosus diameter, and biparietal diameter of the fetal head if possible. The correction factor for object-table top distance for all these latter measurements which are in the same sagittal plane is one-half the intertrochanteric diameter which we have already taken by external pelvimetry. To this measurement the table top-film distance is

added to obtain the object-film distance. The mathematics is completed by the Ball calculator, by the Snow and Lewis slide rule, or by the simple mathematical

formula  $O = I \frac{D-d}{D}$ , in which  $O$  is the object,  $I$  the magnified image as measured on the film,  $D$  the target-film distance, and  $d$  the object-film distance."

Assuming the fetal head to be average in size, the question of probable dystocia at the various planes can be reduced to the following simple observations:

**Dystocia at Inlet:** A conjugate vera under 10 cm. in generally contracted pelvis or under 9.5 cm. in flat pelvis is significant. The contour of the pelvis, such as the angulation of the fore-pelvis and a flattened posterior pelvis, must be considered.

**Dystocia at Mid-pelvis:** A posterior sagittal under 3.5 cm. and a subpubic arch under 5.5 cm. suggest trouble. X-ray examination is indicated to note any convergence of the sacrum and pubis and to determine whether the sacrococcygeal junction is angulated in a manner to interfere with the descent of the head.

**Dystocia at Outlet:** An interpubic measurement under 5.5 cm., an intertuberosus under 9.0 cm., or a pubotuberosus under 11 cm. presages difficulty. A narrow arch will necessitate a lower descent of the head to find an adequate diameter for occipital impingement.

The more conservative management of so-called borderline cases made possible by the methods described has resulted, in the Boston City Hospital, in a decrease of 50 per cent in the number of sections done for cephalopelvic disproportion. Of 300 women in the borderline group, 250, or 83 per cent, were delivered easily, either normally or by low forceps. Three fetal deaths and no maternal deaths were noted in the entire series of 300 cases.

STEPHEN N. TAGER, M.D.

**Relation of the Sacral Promontory to the Pelvic Inlet.** Herbert Thoms. *Am. J. Obst. and Gynec.* 46: 110-116, July 1943.

With the exception of the skull, no portion of the skeleton presents greater individual variations than the pelvis. Apparently this is to be accounted for by its development from a number of bones and the nutritional, mechanical, and hormonal influences to which it is subjected during its growth.

The present study is concerned with one aspect of pelvic variation, the relationships of the upper sacrum, particularly the position of the sacral promontory in relation to the plane of the pelvic inlet.

The roentgenologic findings in 200 women all in their first pregnancy, were studied. It was found that a wide variation exists in the position of the promontory in its relation to the posterior end-point of the antero-posterior diameter of the plane of the pelvic inlet. From a study of the figures given, it is apparent that the position of the forward edge of the sacral promontory is too unreliable to be considered as the posterior end of the true conjugate diameter. In this series, it was at or close to this point in but 30.5 per cent of the cases. Because of this positional variation, the value of the diagonal conjugate diameter as an index of the true conjugate is also questionable. Indeed, two cases are cited with identical conjugate diameters of 12.0 cm. and true conjugates of 11.9 and 10.5 cm., respectively. The estimation of the true conjugate diameter based on the length of the diagonal conjugate was approximately correct in only 38 per cent of the cases in this series.

An analysis of the relationship of high promontory positions and various types of pelvis failed to produce any definite conclusions, though a high promontory was "somewhat, if but slightly, associated with dolichopellic and mesatipellic types of pelvis."

Except in those instances where the promontory is at or near the posterior limits of the plane of the pelvic inlet, it is difficult to see how in high positions it can play a very major part in the mechanism by which the fetal head settles into the pelvis.

This study emphasizes again that roentgenologic methods are an important adjunct to the usual diagnostic obstetric procedures. STEPHEN N. TAGER, M.D.

## GENERAL CONSIDERATIONS

Significance of a Close Co-operation between the Roentgenologist and the Internist. Herbert Ludwig. *Schweiz. med. Wchnschr.* 73: 898-900, July 17, 1943.

Roentgenologic science has developed to an extent that prevents the average internist from having any clear knowledge of technic and its effect on the findings.

Too often this results in a failure to integrate the roentgen findings, which are after all only a description of departures from the normal average, into the clinical picture. A close co-operation, with control of results by operation or necropsy, is essential.

By way of illustration, the difficulties in the diagnosis of duodenal ulcer are considered. Only in the absolutely characteristic case can the diagnosis be made clinically. On the other hand, there are also rare cases in which a roentgen study shows an apparently normal cap. Cases of *Lambia* infestation of the duodenum may give a clinical picture of ulcer; differentiation may be made by a microscopic study of freshly aspirated duodenal contents. In symptomatically atypical cases a careful roentgen study, with special attention to mucosal study of the cap and oblique views, will be needed to clarify the diagnosis.

Three diagnostic problems in which the employment of careful roentgen study led to a correct interpretation of unusual findings are very briefly reported; the final diagnoses in these were subphrenic abscess, bronchial carcinoma, and pulmonary tuberculosis.

LEWIS G. JACOBS, M.D.

## RADIOTHERAPY

### NEOPLASMS

Primary Carcinoma of the Eustachian Tube: A Study of the Evidence of Its Occurrence. Lawrence J. Lawson. *Ann. Otol., Rhin. & Laryng.* 52: 377-390, June 1943.

The importance of searching the nasopharyngeal approach to the ear in the presence of persistent eustachian tube obstruction or unexplained cervical metastases is emphasized. The alert examiner will recognize and make a biopsy of the first tumor bulge associated with persistent tubal closure, especially one which prevents inflation.

It seems highly probable that a fair proportion of lateral nasopharyngeal tumors originate in the eustachian tube. Yet, judging from the published reports, primary carcinoma of the tube is rarely demonstrated. The author quotes a number of cases from the literature and records one of his own. His patient was a man of 59, who came for examination because of slight bleeding from the throat. He complained also of deafness in the right ear, tinnitus, and partial blockage of the right nostril. Examination of the nasopharynx revealed a mass apparently originating in, or in the area of, the right eustachian tube, partly obstructing the right nostril. The tube had been blocked for many months and a consulting otologist had been unable to inflate the right ear. Biopsy revealed transitional-cell carcinoma. No enlarged cervical nodes were observed. Intensive x-ray treatment was given over the tumor: 10,000 r through two ports (5,150 r to the lateral right nasopharynx and 4,450 r to the anterior right malar region). Three upper teeth were removed to facilitate the treatment. The factors were: 400 kv., 3 mm. copper filtration, 75 and 80 cm. distance. Following treatment there was considerable regression of the tumor. Six 2-millicurie radon seeds were implanted in the residual mass, and nine months after its discovery the tumor had disappeared and there was no evidence of extension.

On the basis of his collected series of 14 cases, the author goes on to a discussion of the clinical and patho-

logical features of eustachian tube tumors. It is apparent in most instances that the neoplasm arises from the cartilaginous portion of the tube. Extension to the sphenoidal fissure and orbit may result in an ocular syndrome. There was only one instance of distant metastasis in this group of cases. The pathological diagnosis differs, but Salinger and Pearlman (*Arch. Otolaryngol.* 23: 149, 1936. *Abst. in Radiology* 27: 255, 1936) believe that most of the tumors are transitional-cell carcinomas or lymphoepitheliomas.

In 9 cases of the series there was early evidence of eustachian tube involvement. A firm mobile tumor at the level of the tubular eminence was detected in 7 cases, usually with inward or forward bulging of the pharyngeal wall at this level. Ulceration was not a prominent feature. Salpingoscopy gave evidence of complete obstruction in 6 instances.

The most favorable treatment would appear to be deep x-ray therapy combined with radium or radon. Whether x-ray or radium element is employed, the underlying principles outlined by Coutard should be given proper consideration. One method suggested is to expose the primary lesion and the lymphatic region, if this is involved, daily or twice daily to x-ray or radium for twenty to sixty days. Adequate filtration is used to obtain the most highly penetrating rays. When the primary lesion is small and localized, surface applications of radium or radium and radon may be combined with external x-ray therapy. There is, however, a tendency to regional invasion, particularly into the skull, even though the nasopharyngeal mass may seem to have regressed. STEPHEN N. TAGER, M.D.

Radiation Therapy in Cancer of the Esophagus: Analysis of 85 Cases Observed during the Last Decade. Ernst A. Pohle and Roland R. Benson. *Am. J. Roentgenol.* 50: 89-97, July 1943.

In all cases of esophageal cancer where palliative irradiation is indicated the authors believe that roentgen rays should be given preference. They are safer than intra-esophageal radium therapy. In the upper

third, two lateral fields and one anterior field are used; in the remaining parts of the esophagus an anterior and a posterior field or two oblique anterior fields suffice. The single daily dose per area does not exceed 150 to 200 r (in air), or the total dose 2,000 r per field in the upper esophagus and 1,200 to 1,600 r per area in the lower esophagus. The authors believe that the production of severe reactions is not justifiable in treatment for strictly palliative purposes. In the upper esophagus there is a greater chance of an occasional cure than in the lower esophagus, so that larger dosage in the upper area is justifiable. It is desirable to reach tumor doses of from 3,000 to 4,000 r. With a small number of fields, better control of the entering beams is assured, treatment can be given day after day with the same technic, and calculation of the dose effective in the tumor is more accurate. The size of the field depends on the extension of the growth, which is localized roentgenoscopically and carefully projected on the skin with indelible markings.

Radium in the form of screens or seeds may easily lead to a perforation. Even the introduction of radon seeds loaded into a stomach tube is better carried out after preliminary roentgen therapy, when the tumor has shrunk. Radium may be used along with or immediately at the end of the roentgen therapy or may be given three or four months later to destroy any residual tumor.

Eighty-five patients with cancer of the esophagus have been seen by the authors during the last thirteen years. Over 90 per cent were admitted with advanced lesions and in only a few did the general condition permit of a thorough trial of radiation therapy. The ratio of males to females was almost five to one. The middle third of the esophagus was involved most frequently. Squamous-cell carcinoma was found most often. The average duration of life after hospital admission was 6.7 months, but about 10 per cent of the patients lived longer.

The hopelessness of the prognosis lies chiefly in the fact that these patients are seen too late. Effort must be directed toward an education of both the general practitioner and the public in order to detect these lesions early. Improvement in technic of treatment is also desirable. It is hoped the higher tube voltage now available can improve the situation. One patient in the authors' series with cancer of the upper end of the esophagus treated by roentgen irradiation alone is alive and well for over four years, and another treated by roentgen irradiation and implantation of radon seeds is alive and well for over seven years. These survivals and the degree of palliation obtained in other cases are encouraging.

Illustrative case reports are given with details of treatment in lesions of the upper, middle, and lower portions of the esophagus.

CLARENCE E. WEAVER, M.D.

**Carcinoma of the Cervix: A Study of 233 Cases Including 103 Five-Year Cases with a Survival Rate of 33.9 Per Cent.** James R. Johnston. Pennsylvania M. J. 46: 1062-1066, July 1943

A series of 233 cases of cancer of the cervix have been seen in the tumor clinic at the West Penn Hospital (Pittsburgh, Penna.) in the past ten years. Of these, 103 are five-year cases, the youngest patient being 23 years old and the oldest 84. Twenty-five per cent were under forty years of age. The symptoms varied, but irregular spotting of blood was the predominating sign. The diagnosis is made by careful inspection and palpation of the cervix and by biopsy.

Of the series of 233 cases, 36.5 per cent were in clinical stage I, 40.3 per cent in stage II, 13.7 per cent in stage III, and 9.4 per cent in stage IV. Epidermoid carcinoma was found in 80.2 per cent of the cases, adenocarcinoma in 9.4 per cent, and undifferentiated carcinoma in 10.3 per cent.

The author believes that giving x-ray first lessens the infection and shrinks the massive growth so that the application of radium is made much safer. The x-ray dosage varies with the tolerance of the patient; 1,600 to 2,200 r are given to each of four portals over a period of three weeks. Radium is given in doses of 3,600 to 4,800 mg. hr. In some cases radiation is applied interstitially, in the form of four or five 10-mg. needles inserted in the parametrium. Treatment is not repeated unless there is a recurrence proved by biopsy.

Uremia is a complication due to compression of the ureter as a result of parametrial extension. Relief may sometimes be obtained by using indwelling ureteral catheters. Vesicovaginal fistulas or rectovaginal fistulas occurred in 5 of the author's cases. Non-carcinomatous post-irradiation ulceration occurred in 4 cases.

It is important to re-examine all patients at intervals, as many examples of recurrence have been found, although the patient was symptom-free. The survival rate for the 103 five-year cases was 33.9 per cent.

JOSEPH T. DANZER, M.D.

**Inadequate and Ill-Advised Surgery in the Treatment of Carcinoma of the Cervix.** L. C. Scheffey and G. A. Hahn. Pennsylvania M. J. 46: 1056-1061, July 1943.

The mortality and survival rates reported by a few surgeons who do hysterectomies for carcinoma of the cervix are reviewed by the authors, who compared these figures with series in which surgery was supplemented by irradiation and others in which treatment was by irradiation alone. They believe that in general the radical operation preceded by irradiation does not give as good results as irradiation without operation and characterize the simple type of hysterectomy as a hazardous and delaying measure.

JOSEPH T. DANZER, M.D.

# RADIOLOGY

A MONTHLY JOURNAL DEVOTED TO CLINICAL RADIOLOGY AND ALLIED SCIENCES

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# RADIOLOGY

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## Roentgen Diagnosis of Bronchiogenic Carcinoma<sup>1</sup>

HAROLD L. SHINALL, M.D.

St. Louis, Mo.

THE DIAGNOSIS of bronchiogenic carcinoma still presents many difficulties. It has been estimated that about fifteen thousand persons die annually in the United States of this disease (10).

The clinical diagnosis, based principally on the history and symptoms, is so inaccurate as to be almost in the realm of speculation. In the early stages, physical signs are most often entirely lacking, while in the presence of well established lesions they are so varied that they offer no distinctive evidence of the condition. Correlation of the physical signs and clinical symptoms may, in a small percentage of instances, serve to suggest the diagnosis.

Even roentgenologic methods may be far from conclusive, as is attested by many articles in the literature. Jenkinson (11), for example, speaks of bronchiogenic carcinoma as a "diagnostic enigma" and emphasizes "the pathologic, clinical, and roentgenologic non-conformity of the condition." For this reason we were prompted to undertake a study of bronchiogenic carcinoma to determine the true status of both clinical and roentgen diagnosis and to ascertain, if possible, how greater accuracy might be attained.

All cases of bronchiogenic carcinoma proved by autopsy and microscopic sec-

tion occurring in the last five years at the St. Louis City Hospital were assembled. The pathologic diagnoses were made by Dr. S. H. Gray and Dr. P. A. Wheeler of the Pathology Department. In order to obtain an unbiased picture, the hospital records were accepted just as they were taken in the ordinary routine of hospital work, without particular attention to these cases either clinically or roentgenologically. Only cases coming to autopsy were used in this study. The clinical staff draws its members from two large medical schools.

Analysis of the series thus collected shows that there were found at autopsy 40 cases of bronchiogenic carcinoma in which roentgen as well as clinical examinations had been made. Of these, only 6, or 15 per cent, gave a history sufficiently characteristic to indicate clinically, without roentgen examination, the probability of bronchiogenic carcinoma. Thirty-six patients were referred for roentgen examination of the chest; the findings in these, when considered with the clinical history routinely furnished with the x-ray requisitions, led to a diagnosis of bronchiogenic carcinoma in 16 cases, or about 45 per cent. In some instances, other conditions, such as atelectasis or a large pleural effusion, overshadowed the underlying pulmonary lesion, making diagnosis of malignant growth impossible. If these are

<sup>1</sup> From the Department of Radiology, St. Louis City Hospital, St. Louis, Mo. Presented before the Radiological Society of North America at the Twenty-eighth Annual Meeting, Chicago, Ill., Nov. 30-Dec. 4, 1942.





Fig. 1. Case 1: Large nodular lesion in right hilar zone.

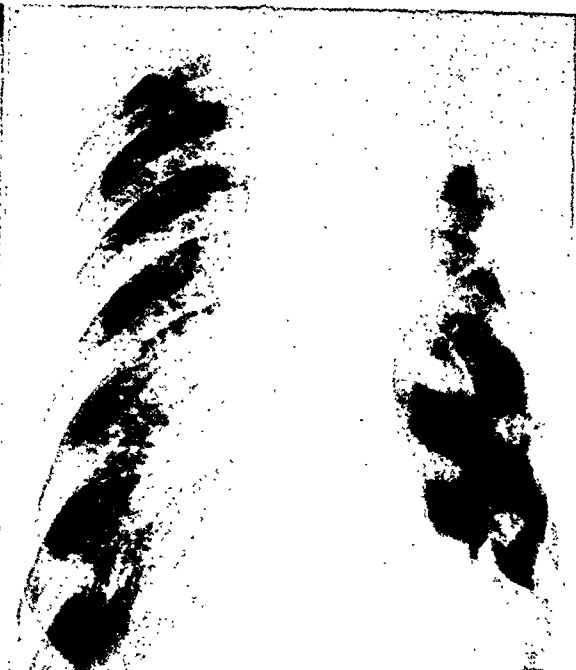


Fig. 2. Case 2: Nodular lesion with zone of atelectasis in left upper lobe.

excluded, the correct diagnoses reach 60 per cent, a figure which agrees closely with that of Olds and Kirklin (15) for the roentgen diagnosis of bronchiogenic carcinoma. It should be borne in mind, also, that the histories accompanying the requisitions for roentgenographic study of clinic patients were sometimes incomplete.

Ewing divides pulmonary carcinoma into three types: (1) bronchial carcinoma of the lining epithelium, (2) bronchial carcinoma arising from mucous glands of the submucosa, and (3) carcinoma arising from the pulmonary alveoli.

(1) Carcinomas arising from the lining epithelium usually grow into the lumen of the bronchus and, when they gain sufficient size, may occlude it, with resulting atelectasis. X-ray examination reveals a rounded nodule, most often in the hilar region. This enlarges gradually, still maintaining its rounded character, until occlusion of the bronchus takes place, when massive atelectasis of the involved lobe causes the sudden appearance of a large area of dense consolidation in the roentgenogram. The characteristics of this consolidation depend upon the lobe involved. With occlusion of the right

upper lobe bronchus, a dense homogeneous area is produced with an S-shaped lower border. The inner, downward bulge is due to the bronchial tumor; the outer, upward convexity is due to contraction from atelectasis. The trachea is displaced toward the involved side (8). Atelectasis of a lower lobe presents a picture similar to atelectasis from any other cause, showing a dense homogeneous triangular shadow occupying the medial lower portion of the lung field, much smaller than the ordinary pneumonic consolidation. Displacement of the heart and mediastinal structures toward the involved side and elevation of the diaphragm are present to some extent but are less marked with single lobe involvement than when the entire lung is atelectatic, since the remaining aerated lung undergoes compensatory emphysema. If the atelectasis involves the middle lobe, it may be distinguished with difficulty from an interlobar effusion.

This type of carcinoma does not tend to metastasize readily. The following cases are fairly typical as to history, radiographic findings, and gross appearance of the chest lesion at autopsy.

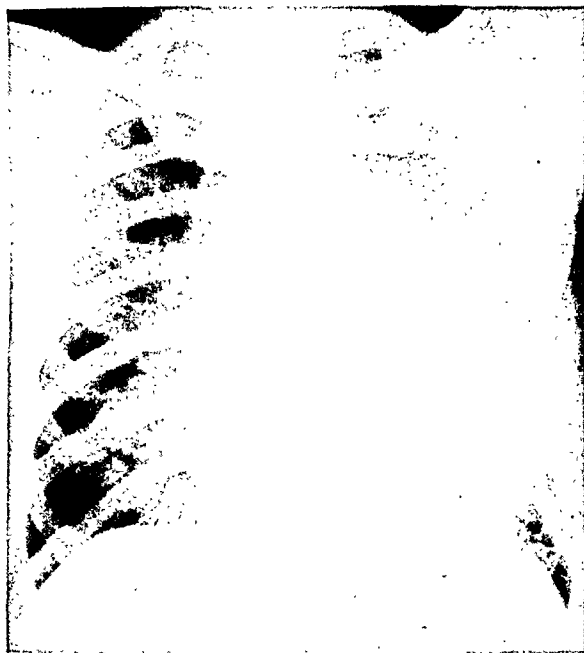


Fig. 3. Case 3: Atelectasis of left lower lobe due to carcinomatous occlusion of bronchi.



Fig. 4. Case 4: Atelectasis of right upper lobe due to carcinoma.

**CASE 1: Nodular Lesion:** A. G., a 63-year-old white male, entered the hospital May 5, 1939, with a history of loss of weight (80 pounds during the preceding year and a half), weakness, coughing and wheezing for several months, pain under the right ribs for several weeks, and disorientation for several days. A roentgenogram made on Jan. 16, 1939, several months prior to admission, showed a large nodular area in the right hilar zone radiating out into the upper lobe.

Autopsy, May 5, 1939, revealed a carcinoma 6 cm. in diameter in the right upper lobe, extending well up into the apex. The right upper lobe bronchus extended into the mass. There was a similar nodular growth within the lumen of the bronchus.

**CASE 2: Nodular Lesion with Atelectasis of Left Upper Lobe:** W. M., a 66-year-old white male, entered the hospital April 10, 1941, with a six months' history of pain in the left side of the chest. Roentgen examination, April 11, 1941, revealed a somewhat rounded shadow in the left hilar region with a linear shadow about one inch in width extending upward into the upper portion of the left lung field.

Autopsy, April 30, 1941, showed the left upper main bronchus completely occluded by a firm mass,  $2 \times 1$  cm., which on microscopic study proved to be a carcinoma.

**CASE 3: Large Mass and Atelectasis of Left Lower Lobe:** R. S., a 46-year-old white male, entered the hospital Nov. 26, 1938, with a history of cough, pain in the chest, and dyspnea for one month. Roentgen examination revealed a consolidation which con-

formed to the lower portion of the left lower lobe, probably due to atelectasis from a bronchial occlusion.

At autopsy, Dec. 20, 1938, diffuse infiltration of the parenchyma by carcinomatous tissue was found in the inner half of the left lung. The large bronchi were completely obstructed by firm carcinomatous tissue.

**CASE 4: Atelectasis of Right Upper Lobe:** G. N., a 52-year-old white male, entered the hospital on Sept. 23, 1937, with a history of loss of weight over a period of one year, malaise for one year, and cough of undetermined duration. Roentgen examination showed an atelectasis of the right upper lobe.

Autopsy, Sept. 24, 1937, revealed a mass in the right upper lobe.

(2) The second type of bronchiogenic tumor is much more bulky and diffuse. It usually causes extrabronchial proliferation but may encircle the bronchus and produce stenosis. Most frequently, however, it breaks down with subsequent infection, giving rise to abscess formation. Such an abscess may be roentgenographically and clinically indistinguishable from an ordinary pyogenic abscess. The following are representative cases of this group:

**CASE 5: Abscess Type:** J. K., a 66-year-old white male, entered the hospital Nov. 2, 1940, with a his-

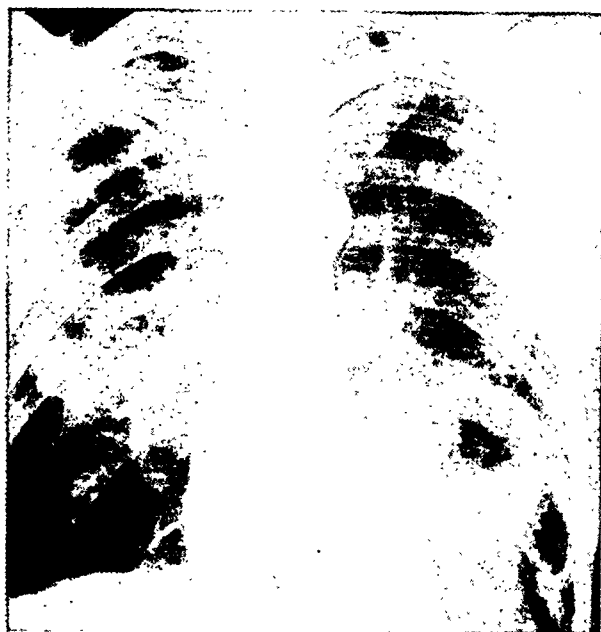


Fig. 5. Case 5: Carcinoma of left lower lobe with abscess formation.



Fig. 6. Case 6: Carcinoma of right upper lobe with destruction in infraclavicular region.

tory of cough and cold with an associated intermittent expectoration of mucopurulent sputum for six months. He complained of pain in the upper chest region, vague abdominal pain at times, and severe dyspnea on exertion. Repeated roentgenograms revealed a large area of destruction in the base on the left, with a surrounding area of infiltration which gradually became more pronounced.

Autopsy, Jan. 20, 1941, revealed a carcinoma at the point of bifurcation of the secondary bronchi in the left lower lobe, with abscess formation in the central zone.

**CASE 6: Destruction:** F. P., white male, 59 years old, entered the hospital Nov. 6, 1940, with a history of hemoptysis two months earlier, cough for two and one half months, and dyspnea for several months. Roentgenograms revealed consolidation over the upper two-thirds of the right lung field, with destruction in the right infraclavicular region.

Autopsy, Nov. 10, 1940, showed a large cavity at the periphery of the right upper lobe. A mass in the right upper lobe, measuring 6 cm. in diameter, was also observed.

**CASE 7: Abscess, Ulceration, Infiltration:** B. W., white male, 57 years old, entered the hospital Feb. 27, 1940, with a history of hemoptysis for one month. He had felt tired and worn out for several months, had daily fever for several months, and had lost weight. Roentgen examination revealed an area of increased density extending out from the hilar region into the base on the left, with an area of decreased density at the periphery.

Autopsy, May 3, 1940, showed the lower lobe to be non-crepitant. The left lower lobe bronchus was found to be obliterated by the presence of an in-

filtrating, firm, grayish white mass about 5 cm. in diameter. Just distal to the fixed specimen was a cavity with an irregular outline.

(3) The third type of lung carcinoma has been described as following two patterns: it may be single and diffuse or multiple and nodular. The diffuse lesion starts as a small patch of consolidation in the pulmonary parenchyma, showing an infiltrating border and spreading by way of the lymphatics and bronchi to involve an entire lobe or lung. In the roentgenogram, the small patch of consolidation spreads with a feathery infiltration, without respect to interlobar septa or other barriers. The multiple or nodular type may be distinguished with difficulty from secondary metastases. The lesions show a more marked tendency to break down than the diffuse type, and even small nodules may present a central area of necrosis. They may, however, grow in size, coalesce, and form large irregular masses (20, 21).

This division is made, though Ewing states that the structure of the pulmonary alveoli remains uncertain. Some authors maintain that there are no epithelial cells lining the alveoli, while others hold strongly the opposite opinion. Certain writers,

among them Arkin and Wagner (1) and Olin and Elliott (16), have previously suggested that all carcinomas of the lung are bronchiogenic in origin, arising from the trachea, bronchi, or bronchioles, and that this is the prevailing opinion. In the five-year period under consideration we did not see a single instance of carcinoma arising from the pulmonary alveoli. There



Fig. 7. Case 7: Carcinoma of left lower lobe with abscess formation, ulceration, and infiltration.

was, however, an instance in which the roentgen appearance would suggest the possibility of an alveolar origin.

**CASE 8: Alveolar or Bronchiogenic (?)**: W. C., a 76-year-old white male, entered the hospital on Aug. 5, 1940, with a history of weight loss of 20 pounds in three months and paralysis of the left side of the body for several weeks. The roentgen report stated: "Examination of the chest reveals an area of consolidation just lateral to the superior portion of the right hilar region. The remaining portion of the right lung and the entire left lung appear clear and free from involvement. Condition is probably due to an area of consolidation and possibly a new growth."

Autopsy, Aug. 31, 1940, revealed a carcinomatous mass in the right upper lobe. The mass was cut through, but due to the extent of the invasion it was not possible to determine its origin from the bronchus.

It is our feeling that the roentgen diagnosis of any lung condition must be correlated with certain elements of the clinical his-

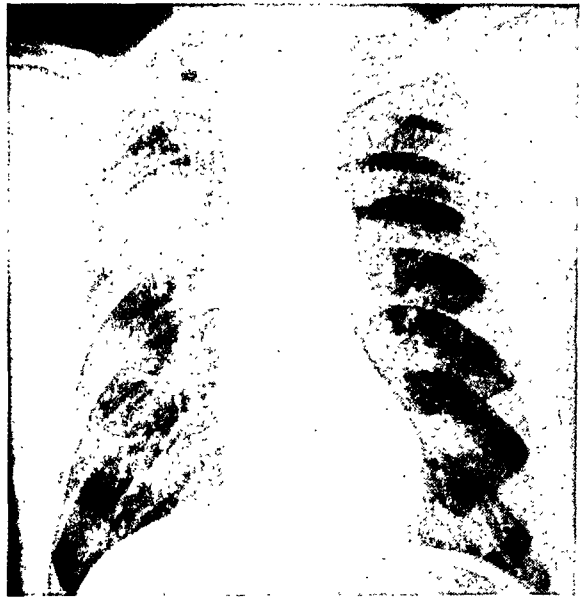


Fig. 8. Case 8: Carcinoma of right upper lobe, of possible alveolar origin.

tory before a diagnosis is made; without such correlation, diagnosis in any case is hazardous. In order to determine the points of greatest importance in these proved cases of bronchiogenic carcinoma, the clinical histories were examined.

Examination of the histories of such patients elicited the following clinical facts of importance in the diagnosis of uncomplicated bronchiogenic carcinoma:

1. *Age of the patient*, usually over forty years, the average in the series being fifty-eight years.
2. *Duration of illness*, three months or over. The average duration before admission to the hospital in this series was seven and one-half months.
3. *Cough*, usually dry and non-productive or none at all.
4. *Expectoration of blood*, usually present at some time during the illness.
5. *Loss of weight*, definite and progressive, usually out of proportion to the extent of lung involvement.
6. *Lack of fever or signs of infection*, with the exception of those cases in which abscess formation intervened.

On further examination it was found that if these points in the clinical history were coupled with a roentgenogram showing a unilateral rounded nodular shadow, usually in the central zone of the lung, it would be possible that the correct diagnosis could be made in 87 per cent of the cases. This is, of course, entirely a matter of speculation, representing the maximum percentage possible; 13 per cent would always remain undiagnosed.

If the case is complicated by infection with abscess formation, there may be fever and the expectoration of mucopurulent sputum. Under these conditions the roentgen picture takes on the appearance of a pyogenic abscess uncomplicated by neoplastic involvement. Even at autopsy the pathologist usually recognizes the presence of abscess formation only and does not suspect the associated carcinoma until microscopic sections of the abscess disclose the true character of the lesion. The chronicity of the abscess might, however, lead one to suspect the presence of a malignant growth.

One thing which we have noted, that sometimes aids in the diagnosis, is the fact that the broken-down carcinomatous tissue seems to afford good soil for growth of fungi and yeasts, and their presence in the sputum always suggests the possibility of malignant involvement (12).

The significance of the correlation of the outlined clinical symptoms with the roentgenographic picture is demonstrated by the high percentage of correct diagnoses attained when this association was made. It will not be sufficient to accept only the scanty clinical information presented with the request for x-ray study. Where so much reliance is placed upon the correlation of roentgen and clinical findings, it is obvious that the latter must be absolutely correct in order to be of value. Nothing short of a clinical-roentgenological consultation in each case of suspected bronchiogenic cancer will suffice. If this is carried out in every instance, a high percentage of correct diagnoses should be attained; if it is not, only a very small per-

centage of diagnoses will be made with any degree of certainty. All of this, however, is only after the condition is well established, and after the disease has progressed to a stage in which little can be done for its cure by our present methods.

There is the likelihood that Paríñas' method of bronchography has contributed to further success in the detection of bronchiogenic carcinoma. He states that when a chest roentgenogram shows an expiratory emphysema, an atelectatic zone in any region of the pulmonary field, or a dense shadow in the neighborhood of the hilus, serial bronchography is indicated to discover the possible existence of bronchial carcinoma (6, 7).

It is obvious, of course, that the solution of the problem of bronchiogenic carcinoma rests to a large extent on its early diagnosis. Here again, the examiner must be alert to the relative frequency of the condition and conscious of the possibility of its presence in an individual case.

#### SUMMARY

After a survey of 40 autopsied cases of bronchiogenic carcinoma seen over a five-year period at the St. Louis City Hospital, in which roentgen as well as clinical studies were made, we feel that a unilateral rounded nodular shadow, usually in the hilar region, coupled with certain features of the clinical history, is of the greatest importance in the diagnosis of uncomplicated bronchiogenic carcinoma.

NOTE: Grateful acknowledgment is extended to Dr. L. R. Sante for his encouragement and assistance in the preparation of this paper.

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#### BIBLIOGRAPHY

1. ARKIN, A., AND WAGNER, D. H.: Primary Carcinoma of the Lung: Diagnostic Study of 135 Cases in 4 Years. *J. A. M. A.* 106: 587-591, Feb. 22, 1936.
2. CRAVER, LLOYD F.: Bronchiogenic Carcinoma. *Am. J. Roentgenol.* 43: 469-478, April 1940.
3. DIAMOND, SIDNEY: Clinical Diagnosis of Primary Carcinoma of the Lung. *Am. Rev. Tuberc.* 43: 713-722, June 1941.
4. EWING, JAMES: Neoplastic Diseases. Philadelphia, W. B. Saunders Co., 4th Ed., 1940, p. 872.

5. FARBEROV, B. E., AND BASLOW, E. A.: Primary Tumors of the Lung: Roentgen Diagnosis and Therapy. Report of 30 Cases. *Am. J. Roentgenol.* 45: 701-713, May 1941.
6. FARIÑAS, P. L.: Serial Bronchography in the Early Diagnosis of Bronchial Carcinoma. *Am. J. Roentgenol.* 32: 757-762, December 1934.
7. FARIÑAS, P. L.: Recent Progress in the Bronchographic Examination of Bronchogenic Carcinoma. *Am. J. Roentgenol.* 44: 370-383, September 1940.
8. GOLDEN, ROSS: Effect of Bronchostenosis upon the Roentgen Ray Shadows in Carcinoma of the Bronchus. *Am. J. Roentgenol.* 13: 21-30, January 1925.
9. HAMMOND, A. E.: Diagnosis and Treatment of Carcinoma of the Lung, with a Statistical Review of 40 Cases. *Arch. Otolaryng.* 31: 780-807, May 1940.
10. HARRINGTON, S. W., AND MOERSCH, H. J.: Primary Carcinoma of the Lung. *S. Clin. North America* 21: 1083-1098, August 1941.
11. JENKINSON, E. L., AND HUNTER, A. F.: Bronchiogenic Carcinoma: Diagnostic Enigma. *J. A. M. A.* 113: 2392-2398, Dec. 30, 1939.
12. KAMPMEIER, R. H., AND BLACK, H. A.: Pulmonary Aspergillosis in Association with Bronchial Carcinoma. *Am. Rev. Tuberc.* 30: 315-319, September 1934.
13. LLOYD, M. S.: Early Classification and Early Diagnosis of Cancer of the Bronchus. *New England J. Med.* 213: 101-113, July 18, 1935.
14. OCHSNER, A., AND DE BAKEY, M.: Carcinoma of the Lung. *Arch. Surg.* 42: 209-258, February 1941.
15. OLDS, J. W., AND KIRKLIN, B. R.: Primary Carcinoma of the Lung: Roentgenologic Study of 206 Proved Cases. *Am. J. Roentgenol.* 44: 357-369, September 1940.
16. OLIN, H. A., AND ELLIOTT, C. A.: Primary Bronchogenic Carcinoma of the Lung: Clinical and Roentgen Study of 38 Cases, over a Period of 12 Years. *Am. J. Surg.* 54: 614-628, December 1941.
17. OVERHOLT, R. H., AND RUMEL, W. R.: Clinical Studies of Primary Carcinoma of the Lung: Analysis of 75 Cases, 21 of Which Were Treated by Pneumonec-tomy or Lobectomy. *J. A. M. A.* 114: 735-742, March 2, 1940.
18. OVERHOLT, R. H.: Surgical Treatment of Pri-mary Carcinoma of the Lung. *Nebraska M. J.* 22: 405-412, November 1937.
19. SAMSON, P. C., AND HOLMAN, E.: Primary Car-cinoma of the Lung: Importance of Early Diagnosis in Increasing Operability and Curability. *California & West. Med.* 53: 208-211, November 1940.
20. SANTE, L. R.: Principles of Roentgenological Interpretation. Ann Arbor, Mich., Edwards Brothers, Inc., 4th Ed., 1942.
21. SANTE, L. R.: The Chest (Vol. XI, *Annals of Roentgenology*). New York, Paul B. Hoeber, Inc., 1931, pp. 395-403.
22. SIMONS, E. J.: Bronchiogenic Carcinoma. *Minnesota Med.* 24: 438-442, June 1941.
23. SINGER, J. J.: Primary Bronchiogenic Car-cinoma: Clinical Study. *Surgery* 8: 910-923, Decem-ber 1940.
24. STEIN, J. J.: Bone Metastasis from Primary Carcinoma of the Lung: Report of Unusual Case. *J. Bone & Joint Surg.* 21: 992-996, October 1939.



# Carcinoma of the Esophagus in Association with Achalasia of the Cardia<sup>1</sup>

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**P**ROLONGED irritation of the skin or mucous membrane has been accepted as an important exciting factor in the etiology of cancer. Yet, there are many conditions in which such irritation (chemical, thermal, bacterial, or traumatic) has existed for a long period without evoking a new growth. One such example is so-called cardiospasm or, more properly, achalasia of the cardia.

The term "achalasia," meaning "without relaxation," is preferable in that it calls attention to the essential functional abnormality. The name achalasia serves, furthermore, to distinguish this disease entity from the truly spastic states of the esophagus occurring in association with ulcers and diverticula of its cardiac end or as a reflex mechanism when disease is present elsewhere in the gastro-intestinal tract. The term "cardiospasm" might be reserved for these latter conditions. Since neither the exciting agent nor the neuropathology of the disease entity under consideration has yet been established, one should stick to the characteristic demonstrable finding, namely achalasia.

The constant irritation of stagnating food and saliva in the esophagus might be expected to be of sufficient degree and duration to be carcinogenic. Rake (1), indeed, describes the sequence of events as irritation by the products of stagnation → ulcerations of the mucosa → attempts at repair → islands of epithelial hyperplasia → papillomatous formation → malignant growth. It is on the basis of such a scheme of pathogenesis that he explains the high incidence of carcinoma in achalasia of the esophagus. In his series of 15

cases he found 3 patients with carcinoma. Similarly, Gottstein (2) urges early treatment because "experience has taught us that, aside from their suffering, the patients are subject to certain dangers." He then cites 3 cases of carcinoma encountered among 33 patients suffering from achalasia.

In sharp contradistinction to these series, showing an incidence of malignant change of 20 and 10 per cent, respectively, are the reports of 301 cases of achalasia by Plummer and Vinson (3) and later of 683 cases by Vinson (4) without any mention of an associated or complicating carcinoma.

Walton (5), in his discussion of the surgical treatment of achalasia, asserts that carcinoma appears to be rare. Kornblum and Fisher (6) have recently reviewed the subject and added 2 cases of their own. They, too, are of the impression that cancer is an unusual complication of achalasia. They say: "While we have not tabulated the actual number of cases of achalasia of the cardia that we have examined roentgenologically, our experience no doubt is similar to that of hundreds of other roentgenologists working in a large city hospital."

Between 1931 and 1942, inclusive, 227 patients with carcinoma of the esophagus were admitted to the Edward Hines Hospital, Hines, Ill. In only one of these cases was achalasia associated with carcinoma. The rarity of such an occurrence appears to warrant the report of that case.

## CASE REPORT

H. M., age 47, was admitted on Oct. 29, 1941. The family history and past history were irrelevant.

In 1931 the patient began to experience vomiting after ingestion of food. A diagnosis of stricture of the cardiac end of the esophagus was then made. The following year (1932) the esophagus was di-

<sup>1</sup> From the X-ray Department and the Tumor Service, Veterans Administration Facility, Hines, Ill. Accepted for publication in August 1943.

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lated under anesthesia, and the patient felt well and comfortable until 1937. For the past four years he had again found that upon eating too fast he would regurgitate part of the food and that "food at times gets stuck at the pit of the stomach." The same sensation was experienced whether liquids or solids were ingested. Close questioning elicited a weight loss of 5 pounds in the preceding four months.

Physical examination was entirely negative. The patient was well developed, rather well nourished, appearing neither acutely nor chronically ill. Blood Wassermann and Kahn tests were negative. The blood count showed hemoglobin 95 per cent, 4,890,000 red cells, 11,600 white cells (88 per cent polymorphonuclears, 11 per cent lymphocytes, 1 per cent monocytes).

Fluoroscopy showed a moderate dilatation of the lower two-thirds of the esophagus, the lowermost end being narrowed but smooth. The widened esophageal lumen presented a localized irregular narrowing at the mid-portion. This filling defect was situated on the right and posterior aspects of the esophageal wall. The stomach was found to be normal. Roentgenograms (Fig. 1) confirmed the fluoroscopic findings. *Roentgen diagnosis:* 1. Carcinoma of mid-portion of esophagus, advanced. 2. Achalasia.

Following the roentgenographic report, esophagoscopy disclosed a ragged, ulcerating and bleeding mass 26 cm. from the teeth. There was no obstruction to the passage of the esophagoscope. Biopsy showed an extremely anaplastic new growth made up of nests of transitional cells and masses of undifferentiated squamous cells, which presented a great variation in size and staining characteristics. Numerous mitotic figures were scattered throughout the microscopic section. *Histologic diagnosis:* Carcinoma, squamous-cell, undifferentiated, grade 3.

Between Nov. 27 and Dec. 24, 1941, the patient received a total of  $2 \times 2,400$  r equally divided between an anterior and a posterior mid-esophageal portal,  $15 \times 8$  cm.; 200 r was administered daily, alternating the fields. The factors were: 200 kv.p., 70 cm. distance, 1.0 mm. Cu filter.

*Course:* On Dec. 26, 1941, the patient was discharged. There was no appreciable change in his symptoms. On July 14, 1942, he entered another hospital because of a constant dull pain in the mid-substernal region. Soon thereafter difficulty in swallowing solids set in. Death occurred on Oct. 23, 1942. Permission for autopsy was not obtained.

#### COMMENT

Unless careful and repeated esophagoscopies are resorted to, carcinoma will rarely be detected early in patients suffering from achalasia. No sharp change in the symptoms marks the appearance of carcinoma, especially when it is located higher up in the esophagus. This is so

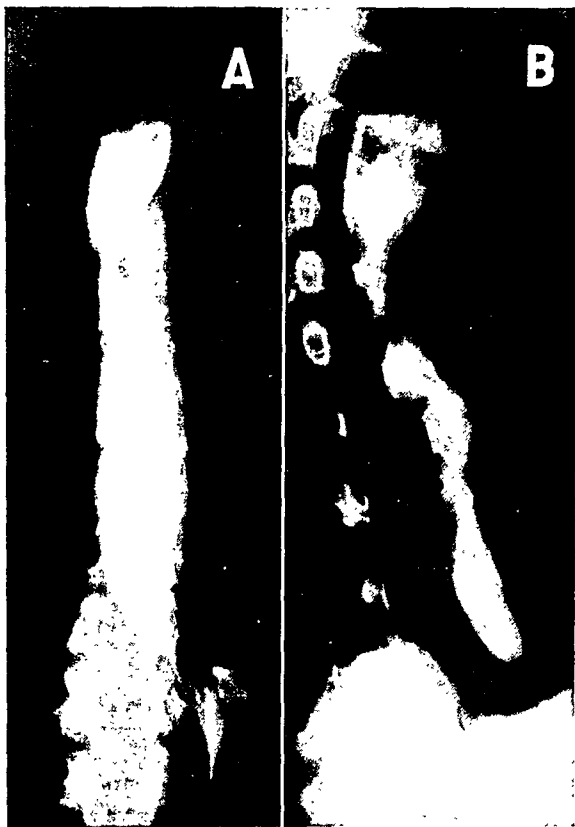


Fig. 1. Carcinoma of the esophagus in association with achalasia. Note the smooth narrowing at the supradiaphragmatic level and the extensive irregular filling defect of the mid-portion of the esophagus. (a) Postero-anterior view. (b) Right oblique view.

mainly because there is no interference with the passage of food. Even at the late stage at which cancer was detected in the case here reported, no obstruction to the passage of the esophagoscope was encountered. Furthermore, small irregularities and filling defects in the dilated esophagus are often caused by and are readily attributed to retained secretion and food particles. Kornblum and Fisher have already stressed the fact that "roentgenologic examination in cases of achalasia of the cardia is not complete until examination has been done after the esophagus has been evacuated of its retained contents." This point is worth re-emphasizing.

Rake, commenting upon a case which showed extensive keratinization and pearl formation, states that the latter features are unusual in esophageal epithelioma. He adduces this finding as evidence of correlation between achalasia and cancer



and as "stressing the marked irritation that must have been present." It is noteworthy, therefore, that the case here reported did not show any keratinization. On the contrary, microscopically it presented a wild growing, anaplastic type of tumor.

To be able to deduce statistically an etiological correlation between carcinoma and achalasia of the esophagus, one must know their general incidence, both individually and in combination. No absolute statistics are available for achalasia. Only scattered case reports or statistics for sectional and selective groups are to be found.

The general incidence of carcinoma of the esophagus varies with race, sex, and distribution of age groups in the population. The Vital Statistics for 1939 (7) reports 2,621 patients dying from cancer of the esophagus in a population of 130,601,000. This gives a crude incidence of 2 per 100,000 living persons. When one corrects for the fact that approximately 99 per cent of esophageal cancers occur in the age group beyond forty, one arrives at a general incidence of 7 per 100,000 (11 for males, 3 for females). A much higher incidence is found in the reliable Swiss statistics (8), which for the years 1901 to 1930 show from 43 to 49 males and from 5 to 8 females dying yearly from carcinoma of the esophagus per 100,000 persons living over the age of thirty years. These figures would be even higher if one were to compute them on the basis of the living age group above forty years.

In 1933 Vinson (9) analyzed 1,000 cases of cancer of the esophagus. In 57 of these, symptoms were of two and a half to thirty years' duration. Vinson does not particularize further as to what antecedent diagnoses and roentgenographic findings were presented by these 57 patients. In the same article he makes the statement that "carcinoma unquestionably develops in certain cases as the result of benign lesions in the esophagus." In the same year (1933), under the heading *The Association of Benign and Malignant Lesions*

*of the Esophagus* (10) he reports only one case of papillary squamous-cell epithelioma grade 2. It would be enlightening to know the incidence of carcinoma discovered by the follow-up at the Mayo Clinic, from which three years earlier (in 1930) he reported 683 cases of achalasia. In his last publication on the subject (1942) he asserts (11) that "malignant change has occurred in the esophagus in a few cases of cardiospasm."

One thus sees that we have as yet no reliable norm by which to judge any possible etiologic correlation between esophageal carcinoma and achalasia.

#### SUMMARY

1. A case of carcinoma of the esophagus associated with achalasia of the cardia is reported.

2. Even though the admittedly important exciting factor of irritation caused by the stagnation of saliva and food has been active over prolonged periods of time, new growths are of exceedingly rare occurrence. This is the more noteworthy in view of the fact that shallow ulcerations, nests of epithelial hyperplasia, and wart-like formations have repeatedly been reported in achalasia.

3. No statistical etiologic correlation of carcinoma to achalasia has as yet been established. To do so, one would have to prove that the incidence of carcinoma in achalasia is significantly greater than that found in the general population of the same age group.

4. Among 227 cases of carcinoma of the esophagus, this reported case is the only one which was preceded by achalasia.

5. The importance of evacuation of the contents of the esophagus prior to roentgen examination is again emphasized.

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#### BIBLIOGRAPHY

1. RAKE, G.: Epithelioma of the Esophagus in Association with Achalasia of the Cardia. *Lancet* 2: 682, Sept. 26, 1931.
2. GOTTSTEIN, G.: Pathology and Therapy of Chronic Cardiospasm. *Allg. med. Central-Zeitung* 77: 563, 1908.

3. PLUMMER, H. S., AND VINSON, P. P.: Cardiospasm: A Report of 301 Cases. *M. Clin. North America* 5: 355, 1921.

4. VINSON, P. P.: Treatment of Cardiospasm. *South. M. J.* 23: 243-247, March 1930.

5. WALTON, A. J.: Surgical Treatment of Cardiospasm. *Brit. J. Surg.* 12: 701-737, April 1925.

6. KORNBLUM, K., AND FISHER, L. C.: Carcinoma as a Complication of Achalasia of the Cardia. *Am. J. Roentgenol.* 43: 364-376, March 1940.

7. UNITED STATES, BUREAU OF CENSUS: Vital Statistics: 12: 250, 1939.

8. Quoted by CRAMER, W.: Importance of Statistical Investigation in Campaign Against Cancer. *Am. J. Cancer* 29: 4, January 1937.

9. VINSON, P. P.: Malignant Disease of the Esophagus. Study of 1,000 Cases. *Northwest. Med.* 32: 320-323, August 1933.

10. VINSON, P. P., AND KENNEDY, F. S.: Association of Benign and Malignant Lesions of the Esophagus. *Am. J. M. Sc.* 186: 660-665, November 1933.

11. VINSON, P. P.: Cardiospasm. *Am. J. Surg.* 56: 79-86, April 1942.



# A New Gallbladder Contrast Medium: Priodax<sup>1</sup>

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FOLLOWING THE report of Menees and Robinson in 1925, advocating the oral administration of sodium tetraiodophenolphthalein as a contrast medium, improvements in the roentgenographic examina-



Fig. 1. Roentgenogram made fifteen hours after administration of Priodax, showing bifid gallbladder with small stones in upper sac.

tion of the gallbladder have resulted largely from changes in equipment and roentgenographic technic. While tetraiodophenolphthalein has produced reliable contrast studies and has therefore come to be the sole preparation employed for that purpose, it has not been entirely satisfactory because of its several undesirable side effects, notably its laxative action, with an associated tendency toward

reverse peristalsis, nausea, and vomiting. Too frequently, also, the substance is not absorbed and remains in the colon, tending to obscure the gallbladder area. While these have not been unsurmountable obstacles and have not prevented the production of satisfactory diagnostic data in most cases, they have warranted a search for a less obnoxious agent.

Apparently an advance in this search has been made with the production, by Dohrn and Diedrich, of  $\beta$ -(4-hydroxy-3,5-diiodophenyl)- $\alpha$ -phenyl-propionic acid. It has been demonstrated that between 60 and 80 per cent of this substance is excreted unaltered, within several days, by the kidneys, whereas only traces of sodium tetraiodophenolphthalein are so eliminated. The assumption is that the undesirable intestinal side actions of the phthalein group are due to the fact that it is eliminated by the colon.

The minimal lethal dose of the new preparation, known commercially as Priodax, has been found to be considerably higher than that of iodophenolphthalein, by actual weight on parenteral administration, and about equal, after correcting for therapeutic dosage, upon oral administration.

In a grouped series of 845 consecutive unselected cases we have found the new preparation to cause much less distress to the patient and to be of considerably more value as a diagnostic contrast medium.

The opacity of the medium has seemed somewhat higher, although it is self-evident that this is something of an individual characteristic and, being subject to variations in technic, is difficult to assay. Of particular value has been the practically complete absence of the opaque substance in the colon. This is due, no doubt, to the fact that it is entirely absorbed in the small bowel and subsequently largely excreted in the urine. We feel that this is of considerable importance, as all too often it

<sup>1</sup> Accepted for publication in October 1943.

is not possible to project the gallbladder away from the hepatic flexure, at least without the expenditure of considerable time and film.

From the point of view of the patient, cholecystography has become considerably less distressing with the use of the new medium. Of the side effects reported, by far the greatest number were mild, and information concerning them was elicited only by leading questions. Of the 845 patients, only 12, or less than 2 per cent, experienced vomiting. Diarrhea of a mild degree occurred in less than a third, and about 20 per cent complained of nausea. Mild griping and slight burning on urination occurred in approximately 12 per cent. Several patients reported a tingling sensation in the throat.

Our preparation of the patient is simple. He eats his regular evening meal, following which he swallows the six ordinary-sized tablets (total 3 gm.) with water. For breakfast he has fat-free fluid (tea) and toast, and reports for examination fifteen hours following the ingestion of the tablets. The only deviation from his usual routine has been the taking of the tablets and the omission of fat with breakfast. Following the initial examination it has been our practice, in the larger proportion of cases, to give a synthetic fatty meal (Cholex) and re-examine in half an hour. This saves time but does not seem otherwise more desirable than the routine fatty meal.

Of the 845 patients examined, 618 (73 per cent) were reported as having normal gallbladders, showing average size, shape, and concentration, without evidence of stones or adhesions, and emptying over 50 per cent following the fatty meal. The remaining 227 (27 per cent) were reported as having malfunctioning gallbladders,

approximately 50 per cent of these showing cholelithiasis.

In 69 of the patients reported as having malfunctioning gallbladders surgical exploration has been carried out, with verification of the roentgenographic impression in every instance. In one case in which normal function was reported, cholecystectomy was done, with the discovery of stones which had not been previously detected. In several cases reported as showing a normal organ an appendectomy was subsequently done and in these the gallbladders were described as seeming normal to palpation and in appearance. In no instance was a gallbladder showing impaired function roentgenographically found to be normal at operation. One carcinoma of the gallbladder was found on exploration.

#### SUMMARY

A clinical trial of a new gallbladder contrast medium (Priodax) demonstrates that it offers definite advantages over sodium tetraiodophenolphthalein.

Appreciation is extended to Dr. Charles C. Fulmer and Dr. William H. Sargent for permission to include their series of cases in this report. The Priodax used was supplied through the courtesy of the Schering Corporation.

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#### REFERENCES

- CAMP, JOHN D.: Origin and Development of the Science of Roentgenology. California & West. Med. 58: 337-341, 1943.
- DOHRN, MAX, AND DIEDRICH, PAUL: Ein neues Roentgenkontrastmittel der Gallenblase. Deutsche med. Wchnschr. 66: 1133-1134, 1940.
- EINSEL, I. H., AND EINSEL, T. H.: Gallbladder Visualization with  $\beta$ (3,5 Di-iodo-4-Hydroxyphenyl)  $\alpha$  Phenyl Propionic acid (Priodax). Am. J. Digest. Dis. 10: 206-208, 1943.
- JUNKMANN, K.: Perorale Cholecystographie mit Biliselectan. Klin. Wchnschr. 20: 125-128, 1941.
- MENEES, T. O., AND ROBINSON, H. C.: Oral Administration of Sodium Tetraiodophenolphthalein for Cholecystography. Radiology 5: 211-221, 1925.

# Oral Cholecystography

## A Comparative Study of the Single- and Divided-Dose Method with Contrast Media in Liquid and Solid Form<sup>1</sup>

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THE INTRODUCTION of a new contrast substance for gallbladder visualization,  $\beta$ -(4-hydroxy-3, 5-diiodophenyl)- $\alpha$ -phenyl-propionic acid (Priodax), gave us the opportunity and incentive to compare the drug with sodium iodophthalein for shadow-producing qualities; to determine the relative frequency of side effects, particularly on the gastro-intestinal tract, and to review the procedure of cholecystography in general.

Following the report of Stewart and Illick (9) in 1934, we began using a modified form of their "intensified technic." If 3.5 gm. of sodium iodophthalein given orally failed to produce a distinct shadow of the gallbladder sixteen hours later, the patient was given a dose of 1.5 gm. of the dye after a fat-free lunch and a similar dose following a fat-free supper. A second examination was then done the following morning, or approximately forty hours after the original dose of dye had been given. This method resulted in considerable improvement in the accuracy of oral cholecystography in our hands and it was continued for several years. In 1938 the method was changed, and all patients were given two doses of the dye (a total of 7.0 gm.), the first dose being administered after a regular noon lunch and the second after a fat-free supper. The roentgen examination was concluded the following morning. With this technic the accuracy of the method has been extremely high.

Faint and questionable shadows were not often encountered and absence of a distinct gallbladder shadow could be relied upon in the vast majority of cases as indicating gallbladder disease or cystic duct obstruction.

The literature on oral cholecystography has become extensive, and it is not our purpose to review it here. Even in recent years there have been continued attempts to improve the diagnostic accuracy of the method by variations in technic of administration in order to obtain higher degrees of concentration and better shadow densities. In our experience we have found it advantageous to keep the method of administration as simple as possible, and it has not been necessary to resort to the use of paregoric or alkalies to aid in absorption or concentration. The importance of a meticulous technic in the making of the roentgenograms has been emphasized before. This factor, in our opinion, is of more importance than any other in obtaining satisfactory and reliable results, providing the patient has received an adequate amount of the contrast substance and has retained it. In recent years roentgen films have been improved considerably in contrast and in speed. This improvement is particularly noticeable in soft-tissue studies. The development of the rotating anode tube and the high-speed Potter-Bucky grid made possible the taking of gallbladder roentgenograms at faster speeds, with consequent improvement in detail as a result of the fine focal spot in the tube and the elimination of motion. We were desirous, therefore, of

<sup>1</sup> Read by title at the Twenty-ninth Annual Meeting of the Radiological Society of North America, Chicago, Ill., Dec. 1-2, 1943.

determining whether these factors might not have resulted in sufficient improvement in the technical qualities of our gallbladder films so that the double dose method might be eliminated, thereby simplifying the procedure.

The first reports on the use of  $\beta$ -(4-hydroxy-3,5-diiodophenyl)- $\alpha$ -phenyl-propionic acid came from Germany, where it was given the name of Biliselectan. In this country it has been marketed under the name of Priodax.<sup>2</sup> Since the chemical name of the drug is cumbersome, it will hereafter be designated as Priodax in this paper. Priodax is manufactured in tablet form, each tablet containing 0.5 gm. of the drug. The dose recommended is 3.0 gm. Priodax contains 51.5 per cent iodine. It is largely excreted in the urine, 61 to 83 per cent being recovered in three days, according to the manufacturer.

In 1940, Kleiber (4) reported on the use of Biliselectan (Priodax) in 55 cases. In 25 no shadow was seen. These were checked by the intravenous injection of tetraiodophenolphthalein and the same results were obtained. Twenty-four of the patients came to operation and gallbladder disease was present in all. There were no ill effects from the drug. In the same year Grunke and Finger (3) described their experiences with this drug. In a series of 18 normal cases an excellent gallbladder shadow was obtained in 16, while in the remaining 2 it was fair. Among 27 patients with definite gallbladder disease, no shadow was obtained in 24, and a faint shadow in 3. Among 51 patients suspected of having gallbladder disease, excellent shadows resulted in 30; in 13 the shadows were faint to moderate in density; in 8 no shadow was obtained. In 4 patients there was diarrhea and 2 patients vomited. There were no other ill effects. Lauer-Schmaltz (5), also in 1940, used Biliselectan in 45 cases, with 33 showing good shadows, 11 negative, and 1 questionable. He observed no ill effects from the drug. Rating (8), in 1941, reported good re-

sults with Biliselectan. The chemistry of Biliselectan was described by Dohrn and Diedrich (1) in 1940.

In America the pharmacology of Priodax has been studied by Modell (6). Using cats as the experimental animal, he found that the intravenous injection of the drug in doses as small as 50 to 75 mg. per kilo caused excitement with respiratory stimulation. Larger doses led to convulsions. The intravenous LD 50 was about 150 mg. per kilogram. The drug was much less toxic when administered orally, and animals survived doses as high as 1,000 mg. per kilogram of body weight, though individual differences occurred. The drug when given over a period of days in total amounts of 250 mg. per kilogram of body weight caused impaired appetite, nausea, vomiting, and general depression. These effects did not occur after intravenous injection. Albuminuria was an outstanding effect but was transient. Doses up to 1,000 mg. per kilogram were without effect on the non-protein nitrogen level of the blood, the phenolsulfonphthalein excretion, the red blood cell count, fragility of the red blood cells, and the blood clotting time, even though some of the larger doses proved fatal. No histologic changes were found in the kidneys.

Einsel and Einsel (2), in a brief report on the use of Priodax, clinically, in 50 unselected cases, stated that a single dose of 3.0 gm. was sufficient to produce good visualization of the normal gallbladder, equal or superior to that obtained with soluble iodophthalein. No obnoxious symptoms were produced by the drug. Freedom from nausea, vomiting, and diarrhea was an outstanding feature.

#### METHOD OF STUDY

In view of these favorable reports, it was decided to test the drug on a series of patients and to repeat the test on as many as possible with soluble iodophthalein. It was thought that only in this way could a satisfactory comparison of the shadow-producing qualities of the two be obtained, and at the same time the frequency of side

<sup>2</sup> Manufactured by the Schering Corporation, Bloomfield, N. J.

TABLE I: SIDE EFFECTS FOR ENTIRE SERIES

	Nausea	Vomiting	Diarrhea Mild	Diarrhea Moderate	Diarrhea Severe	Total Diarrhea	Burning Urination	Burning Throat
Priodax (114 cases)	32 (28.1%)	2 (1.7%)	13 (11.4%)	6 (5.3%)	7 (6.1%)	26 (22.8%)	17 (15%)	9 (8%)
Iodophthalein (80 cases)	36 (45%)	4 (5%)	11 (13.7%)	4 (5%)	8 (10%)	23 (28.7%)		

effects on the gastro-intestinal tract be studied. Since we were desirous also of comparing the efficiency of both drugs in single and multiple doses, it was decided to use the "intensified technic" described earlier. The Priodax was given in doses of 3.0 gm. and, if multiple doses were needed, two additional doses of 1.5 gm. were given. Iodophthalein was given in doses of 3.5 gm. for the single dose, and the second and third doses were 1.5 gm. each. Patients from one surgical and two medical wards were chosen for this study. In all subjects the procedure of cholecystography was requested by the clinical staff as part of the diagnostic work-up. There were, therefore, no strictly "normals" in the group, and the examinations represent a cross section of cholecystography as seen in this institution. Because of economic and other reasons, it was not possible to study every patient with "no shadow" on the initial examination by the double dose method, and for the same reasons the number of patients who were given both drugs is limited to 46. In view of the constancy of the results obtained, however, it is believed that this number is sufficient to give an accurate comparison. At the time of roentgen examination each patient was questioned with reference to unpleasant effects.

#### RESULTS

Priodax was given to 114 patients and iodophthalein to 80. Among these were 46 who received both drugs. Table I lists the side effects in the entire series. It was rather surprising to find that 28.1 per cent of patients complained of nausea after taking Priodax as compared to 45 per cent for iodophthalein. Since it is difficult to evaluate a subjective complaint such as

nausea, and since in some of the patients the nausea may have been a result of their disease, these figures may not be of significance. Vomiting occurred in only two (1.7 per cent) of the Priodax cases as compared with four (5 per cent) for iodophthalein. The incidence of diarrhea after Priodax is also of some interest, some degree occurring in 22.8 per cent of the 114 patients. With iodophthalein diarrhea occurred in 28.7 per cent of 80 cases. The incidence of severe diarrhea (four to ten stools) was somewhat greater for iodophthalein, 10 per cent as compared to 6.1 per cent for Priodax. Burning on urination was noted by 15 per cent of the patients taking Priodax, apparently due to the excretion of the substance in the urine. Eight per cent complained of burning in the throat after swallowing the tablets. During the latter part of the study we were furnished with coated tablets, which eliminated this symptom. The shadow-producing qualities of the drug were not influenced by the coating.<sup>3</sup>

A comparison of the shadow densities with the two drugs is given in Table II.

TABLE II: SHADOW DENSITY FOR ENTIRE SERIES

	No Shadow	Faint Shadow	Moderate Shadow	Good Shadow
Priodax (114 cases)	29 (25.4%)	3 (2.6%)	10 (8.7%)	72 (63.3%)
Iodophthalein (80 cases)	16 (20%)	6 (7.5%)	14 (17.5%)	44 (55%)

In interpreting the results, the density of the gallbladder shadow is listed according to degree, thus: no shadow, faint shadow, fair shadow, and good shadow. When the examination was to be repeated with the

<sup>3</sup> Coated tablets will not be available for the duration of the war.

other drug, an interval of at least three days was allowed to avoid a summation effect. In approximately one-half of the cases, Priodax preceded iodophthalein and *vice versa*. The percentage of fair and good shadow results is almost identical with the two drugs, being 71.9 per cent for Priodax and 72.5 per cent for iodophthalein. These figures can be considered the normals as far as the concentrating response of the gallbladder is concerned. There was a somewhat greater incidence of faint shadows with iodophthalein, 7.5 per cent as compared to 2.6 per cent for Priodax.

TABLE III: SIDE EFFECTS FOR COMPARATIVE SERIES OF 46 CASES

DIARRHEA	
No diarrhea with either Priodax or iodophthalein	28
Diarrhea with both.....	8
Diarrhea with Priodax, none with iodophthalein	3
Diarrhea with iodophthalein, none with Priodax	5
Record incomplete.....	2
NAUSEA	
No nausea with either.....	25
Nausea with both.....	7
Nausea with Priodax, none with iodophthalein..	1
Nausea with iodophthalein, none with Priodax..	11
Record incomplete.....	2
VOMITING	
No vomiting with either Priodax or iodophthalein	41
Vomiting with both.....	0
Vomiting with Priodax, none with iodophthalein	0
Vomiting with iodophthalein, none with Priodax	3
Record incomplete.....	2

TABLE IV: SHADOW DENSITY FOR COMPARATIVE SERIES OF 46 CASES

Shadow densities similar with both drugs (41 cases)	
No shadow.....	11 cases (stones in six)
Faint shadow.....	1 case (no stones)
Fair shadow.....	5 cases (stones in one)
Good shadow.....	24 cases (stones in one)
Shadow densities dissimilar (5 cases)	
One case faint with Priodax, good with iodophthalein	
One case no shadow with Priodax, faint with iodophthalein	
Two cases good with Priodax, fair with iodophthalein	
One case good with Priodax, faint with iodophthalein	

The results in the comparative series of 46 cases are listed in Tables III and IV. Table III gives the frequency of side effects on the gastro-intestinal tract and Table IV the comparison of shadow densities. It will be seen that the results were similar in 41 cases, dissimilar in 5 cases. In 2 of this latter group better shadows were obtained with iodophthalein, and in 3 better shadows were produced by Priodax.

Table V gives the results in the cases in

TABLE V: RESULTS OF "INTENSIFIED TECHNIC"

PRIODAX (16 cases)	
In 12 cases, no shadow after single dose, no shadow after multiple doses	
In 1 case, faint shadow with stones after single dose, same after multiple doses	
In 2 cases, no shadow after single dose, faint shadow after multiple doses	
In 1 case, faint shadow after single dose, fair shadow after multiple doses	
IODOPHTHALEIN (5 cases)	
In 2 cases, no shadow after single dose, no shadow after multiple doses	
In 1 case, faint shadow after single dose, faint shadow after multiple doses	
In 1 case, fair shadow after single dose, good shadow after multiple doses	
In 1 case, no shadow after single dose, faint shadow after multiple doses	

which the intensified technic was used. In 16 Priodax cases the use of additional drug failed to increase the shadow density in 13, while in 3 a slight increase was observed. The method was used in 5 iodophthalein cases, with no change in 3 and slight increases in the other 2.

DISCUSSION

As mentioned earlier, it is difficult to evaluate the significance of nausea in these patients. With iodophthalein a fairly high incidence of this symptom might be expected in view of the unpleasant taste of the drug and the difficulty of masking it satisfactorily. We used a powder form, dissolving it in water and adding grape juice. Our results with Priodax are somewhat at variance with the reports of others, since 28.1 per cent of our series complained of nausea. That the drug may not be without some effect on the gastro-intestinal tract when given orally is suggested by the experimental work of Modell (6) referred to earlier.

The incidence of vomiting with Priodax was only 1.7 per cent. Even with iodophthalein vomiting occurred in only 4 of 80 patients (5 per cent), hardly a significant figure. Three of these 4 patients had gallbladder shadows of excellent density while one showed no shadow. In one case the vomiting was extremely troublesome, yet a very good gallbladder shadow resulted. In the comparative series of 46 patients, 3 vomited after taking iodophthalein (good shadows in all), none after Priodax. It



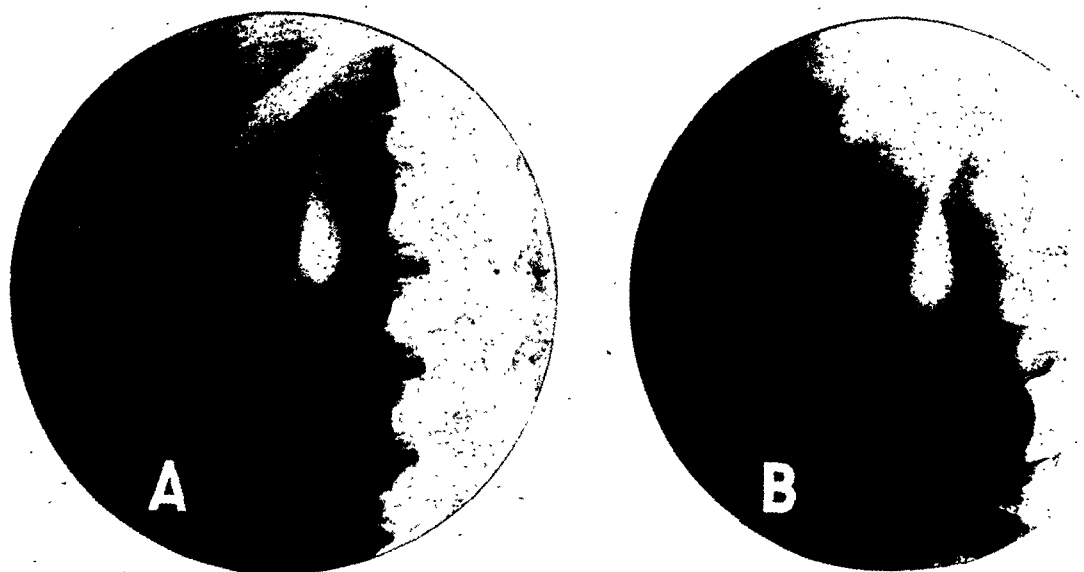


Fig. 1. A. Appearance of the gallbladder fifteen hours after a single dose of iodophthalein, showing good density. B. Same patient fifteen hours after a 3-gm. dose of Priodax. The density of the shadow is comparable to that obtained with iodophthalein.

appears, therefore, that the incidence of vomiting is somewhat higher with iodophthalein but it does not occur often enough to be a disturbing factor and seldom interferes with visualization when the gallbladder function is normal.

We were interested particularly in the results with reference to diarrhea. Our findings indicate that diarrhea occurs almost as frequently with Priodax as it does with iodophthalein (22.8 per cent and 28.7 per cent, respectively) but that the diarrhea is likely to be a little more severe with the latter drug. That Priodax is not entirely innocuous in this respect is indicated, also, in the comparative series, 3 patients having diarrhea after Priodax and none after iodophthalein. Again, however, diarrhea was slightly more frequent after iodophthalein (13 cases as compared to 11 for Priodax). It is our impression from these studies that gastro-intestinal side effects are nearly as frequent with Priodax as with iodophthalein but that these effects rarely influence the end-result with either drug.

The density of the gallbladder shadow produced by the two drugs was so similar that, in the majority of cases (41 out of 46), the films were identical (Figs. 1 and

2). This is borne out in the complete series. While the number of "good" shadows was greater for Priodax, the totals of "fair" and "good" shadow cases are practically identical, 71.2 per cent and 72.5 per cent. Since these constitute the normal cases, there is no particular advantage for either drug.

The burning on urination noted by some patients after taking Priodax was of little consequence and it is doubtful if most would have noted it if their attention had not been directed to it by questioning. Burning in the throat was, similarly, not a serious complaint and was eliminated by the use of coated tablets.

The patients from one ward received no cleansing enemas or other preparation of the bowels prior to roentgenography. If gas obscured the gallbladder, pitressin was used according to the method described in a previous paper (7). This was found to be entirely satisfactory. Priodax has the advantage of palatability. It is certainly easier to dispense, being in tablet form. Patients were instructed to take the tablets with sips of water after a fat-free supper, to avoid eating after this, and to report to the roentgen-ray department at the specified time the following morning.

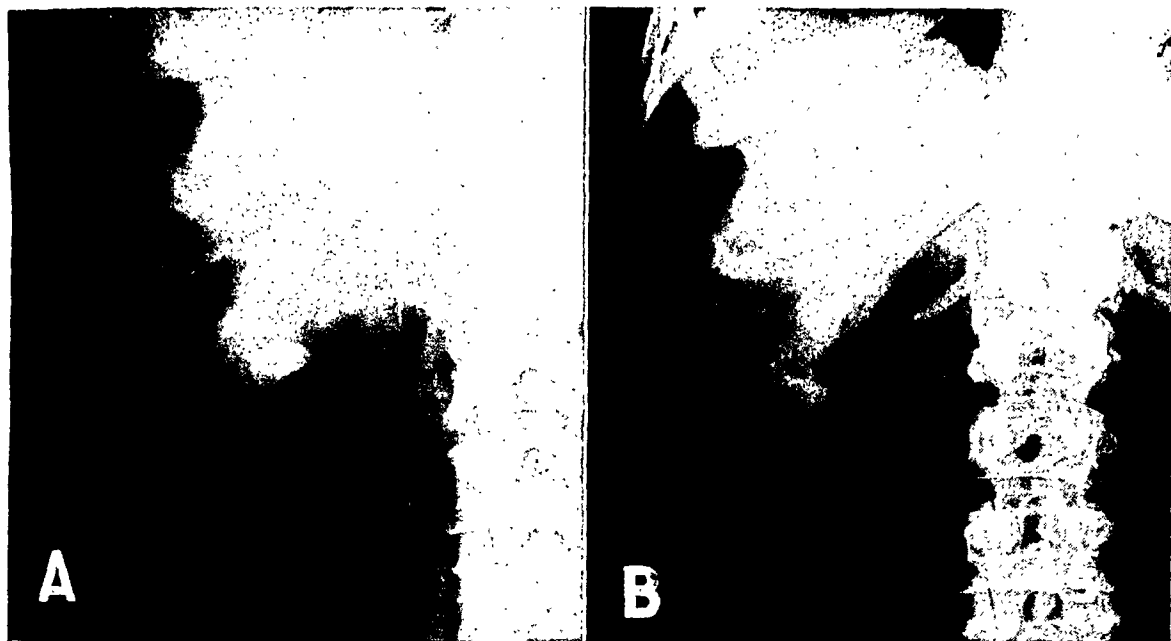


Fig. 2. A. Gallbladder shadow after a 3-gm. dose of Priodax. The shadow is of good density. B. Same patient after a single dose of 3.5 gm. of iodophthalein. Gallbladder density is comparable to that obtained with Priodax.

These simple directions were found to be satisfactory with both drugs.

Although the number of cases in which the intensified technic was used is not large, especially with iodophthalein, we were impressed with the fact that when a single dose of the drug failed to produce any shadow of the gallbladder, additional doses rarely resulted in its demonstration. This certainly was true of Priodax and, since the comparative series revealed no significant difference in the shadow-producing qualities of the two, we believe it is equally true of iodophthalein.

The importance of painstaking technic in the making and processing of the roentgenograms is particularly stressed. We have found the use of a rotating anode tube and fractional second exposures (one- or two-tenths of a second) extremely helpful in giving clear, sharp shadows with sufficient contrast.

#### SUMMARY AND CONCLUSIONS

In a series of 46 patients cholecystographic examination was done with both sodium iodophthalein and a new drug, Priodax. No significant differences were

found in the shadow-producing qualities of these two drugs when given in single doses of 3.5 and 3.0 gm., respectively. The incidence of nausea and vomiting was slightly less with Priodax, but diarrhea occurred nearly as frequently as with iodophthalein, although it tended to be less severe. Including the 46 patients, a total of 194 examinations were studied in 148 individuals, 114 receiving Priodax and 80 iodophthalein. In this larger series the results were not appreciably different. The figures in Table II suggest that with Priodax there will be fewer cases showing faint shadows. Priodax has the advantage of ease of dispensing and of administering.

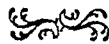
The importance of the technical procedure in roentgenography is emphasized. The use of high milliamperages (200 ma.), a rotating anode tube, and short exposure times (one- to two-tenths of a second) improved the diagnostic quality of the roentgenograms. Single doses of either drug were found to be satisfactory. If faint shadows result, the use of an intensified technic with repeated smaller doses will occasionally produce an intensification of the shadow, but this is not necessary as a

rule. Providing the technical features of the examination are given careful attention, we have found that the procedure can be simplified. The patient is instructed to take the drug after a fat-free supper, to avoid eating after this, and to report to the department at eight o'clock the next morning. If gas obscures the gallbladder, pitressin is administered and the examination concluded. If pitressin is contraindicated, a cleansing enema is given but is seldom as satisfactory.

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#### REFERENCES

1. DOHRN, M., AND DIEDRICH, P.: Ein neues Röntgenkontrastmittel der Gallenblase. *Deutsche med. Wchnschr.* 66: 1133-1134, 1940.
2. EINSEL, I. H., AND EINSEL, T. H.: Gall Bladder Visualization with  $\beta(3,5\text{-Diiodo-4-Hydroxyphenyl})\alpha$  Phenyl Propionic Acid (Priodax). *Am. J. Digest. Dis.* 10: 206-208, 1943.
3. GRUNKE, W., AND FINGER, H.: Cholecystographie mit dem neuen peroralen Kontrastmittel Biliselectan. *Klin. Wchnschr.* 19: 1187-1189, 1940.
4. KLEIBER, N.: Zur Frage der peroralen Darstellung der Gallenblase. *Deutsche med. Wchnschr.* 66: 1134-1135, 1940.
5. LAUER-SCHMALTZ, W.: Erfahrungen über perorale Cholezystographie mit dem neuen Kontrastmittel Biliselectan. *München. med. Wchnschr.* 87: 1139-1140, 1940.
6. MODELL, W.: Pharmacology of  $\beta(3,5\text{-di-iodo-4-hydroxyphenyl})\alpha$  Phenyl Propionic Acid. *J. Lab. & Clin. Med.* 27: 1376-1384, 1942.
7. PAUL, L. W., AND BEATTY, S. R.: Use of Pitressin for the Elimination of Intestinal Gas in Roentgenography of the Genitourinary Tract and Gallbladder. *Am. J. Roentgenol.* 38: 776-778, 1937.
8. RATING, B.: Über ein neues Kontrastmittel zur Röntgendarstellung der Gallenblase (Biliselectan). *Fortschr. a. d. Geb. d. Röntgenstrahlen* 63: 99-110, 1941.
9. STEWART, W. H., AND ILLICK, H. E.: Sources of Error in Oral Cholecystography, with Suggested Methods of Correction. *Radiology* 23: 663-671, 1934.



# Cholecystography with Priodax:

## A Report on 600 Examinations<sup>1</sup>

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ROENTGEN EXAMINATION of the gallbladder with the aid of tetraiodophenolphthalein is one of the most valuable additions to the diagnosis of gallbladder disturbances. Its introduction by Graham and Cole in 1924 marked a major step forward; and today, this test remains the most important single diagnostic method in this field. Its accuracy, on correlation with surgical exploration, has been variously reported as between 90 and 98 per cent. The possibility of diagnosing adenomas and tumors of the wall of the gallbladder by this method has been noted by Kirklin.

It is generally agreed that intravenous administration of tetraiodophenolphthalein, although perhaps of greater diagnostic accuracy, does not constitute the method of choice because of bothersome, and at times dangerous, side effects. While intravenous cholecystography is still used routinely by some, it has been generally abandoned in favor of the oral method. In recent years, appropriate technics of administration and of radiological examination with the latter method have been firmly established by Kirklin and others.

Employment of the double dose method has not been widely accepted, primarily because of inconvenience to the patient. Again, with too dense a concentration of dye, small radiolucent stone shadows may frequently be obscured.

The method of repeating the dosage of dye immediately following the finding of a non-functioning gallbladder without stones has, in my opinion, had a more evident justification for general use. It has been noted that approximately one out of four such non-functioning gallbladders has been found to have normal function when the same amount of tetra-

iodophenolphthalein was given on the day of the first x-ray examination, and when the patient abstained from any fatty food for the next twenty-four hours. These false non-functioning gallbladders can probably best be explained on the basis of faulty absorption of dye from the intestinal tract, and by diarrhea and other physiological factors. In such cases, there is apparently no reason to suspect the gallbladder itself as the primary seat of disease.

If one considers the convenience and well-being of the patient, tetraiodophenolphthalein leaves much to be desired. There are far too many complaints of diarrhea, nausea, and vomiting following its use. Indeed, vomiting may become particularly severe, with consequent loss of contrast material and failure of visualization. At times, patients complain of the persistence of after-effects and refuse to submit to another gallbladder examination. While there are always some hysterical or neurotic patients who tend to exaggerate, there can be no question that the examination may be very severe in its effects on persons who are already weak and exhausted.

Several attempts have been made to find a cholecystographic contrast material which would not give rise to the objectionable effects of tetraiodophenolphthalein and, because of better absorption, might produce superior cholecystographic shadows. Some of these potential dyes have proved to be toxic, while others afford but poor radiologic contrast.

In 1940, Dohrn and Diedrich systematically experimented with a large number of iodine-bearing compounds which were capable of being excreted by the liver. After eliminating many of these compounds because of toxicity or because of excretion by the kidneys rather than by the liver, they finally selected, as the sub-

<sup>1</sup> Accepted for publication in January 1944.

stance most suitable for their purpose,  $\beta$ -(4-hydroxy-3,5-diiodophenyl)- $\alpha$ -phenylpropionic acid. This is a white crystalline powder, insoluble in water and having an iodine content of 52 per cent. The lethal dose in rabbits (according to Junkmann) is 2.8 gm. per kilogram orally. Rabbits tolerate 1 to 2 gm. per kilogram orally without conspicuous phenomena. Modell's findings on the pharmacology of this substance are substantially in agreement. Since the dosage for man is 3.0 gm., this would seem far removed from the experimental danger line of toxicity.

This substance is excreted with the bile in adequate concentration. Junkmann notes that about 50 per cent of the chemical is excreted with the urine during the first twenty-four hours after administration; while only 3 to 4 per cent of tetraiodophenolphthalein is excreted by the urine, most of it being eliminated by way of the colon. He has found a similar type of excretion in human beings.

This substance was tested clinically by Kleiber, Rating, and by Grunke and Finger, all of whom found it remarkably well tolerated and free from side actions. They observed no toxic effects clinically. Good gallbladder shadows were obtained even in cases with intestinal complications. Some of these investigators consider the diagnostic worth of the new medium equal to that achieved with the intravenous administration of tetraiodophenolphthalein.

I have used Priodax, as the preparation is known in this country, in 600 gallbladder examinations. Administered in tablet form, a total of 3.0 gm. of the active substance constitutes the usual dose. A fat-free supper is eaten at six P.M. No preliminary laxative or diet is given. Immediately after supper, the tablets are swallowed, whole or crushed, with water or fruit juice. The patient is told not to chew them because of the unpleasant burning and bitter taste. Following this, the patient abstains from food (except water or fruit juices) until the examination is completed the following morning. A cleansing enema in the morning is advised.

The first film is taken approximately fifteen hours after administration of the Priodax. If this shows gallstones, no further x-ray studies are done. If there is too much gas overlying the bladder, pitressin is given, or a cleansing enema if pitressin is contraindicated. Should no gallbladder shadow be seen, a larger film is taken after another hour. Where a normally functioning gallbladder without stones is found, 4 ounces of cream are given to the patient and another film is taken in forty-five minutes. The patient should be rotated fairly often in order to remove gas shadows in the colon from the region of the gallbladder. At times, several films are necessary to determine the absence or presence of stones. It is most important that the films be viewed by the radiologist or a technician with adequate understanding of the factors involved, before the patient is dismissed. Many a re-examination can thus be avoided. It has been noted that gas and the presence of the medium in the colon (leading to confusing shadows) are not so frequent with Priodax as with tetraiodophenolphthalein.

Comparatively little attention is paid to the decrease in size of the gallbladder or its complete emptying after the fat meal. This change in size and contour is of greater diagnostic value for the demonstration of non-opaque stones than for emptying function. A second fat-free meal is occasionally given in order to differentiate between gas shadows and stones, rather than to achieve a certain degree of emptying.

Priodax was much better tolerated than tetraiodophenolphthalein, the nausea, vomiting, and diarrhea usually associated with the latter being markedly decreased in frequency and severity with the former. Only occasional and slight complaints were voiced with respect to nausea and vomiting. About 8 per cent of the patients answered affirmatively upon direct questioning. Only 0.08 per cent complained of vomiting. There were one or two loose stools in 8 per cent of the cases; diarrhea, with three or more stools, was present in

3 per cent. Several patients had taken tetraiodophenolphthalein on previous occasions and every one of these emphatically preferred Priodax.

Three out of 100 male patients complained of slight burning on urination, a finding seldom complained of by females. This symptom is explained by the fact that more than half of the substance is excreted by way of the kidneys. Urine examination in 30 patients showed no irritation of the kidneys; no albumin was found and casts were absent. The number of erythrocytes and leukocytes was normal in these patients.

In one patient, contrast filling of a hydronephrotic kidney pelvis was observed on all films following the administration of Priodax. An intravenous pyelogram with diodrast subsequently confirmed the diagnosis of hydronephrosis of the right kidney, with delayed kidney excretion. No ill effect in the patient was noted.

In this series, no instances of iodine sensitivity were observed; nor was there any evidence that the oral administration of Priodax had exerted harmful effects on the health of the patients.

Of the 600 examinations with Priodax, 80 per cent showed excellent gallbladder shadows; in 8 per cent the contrast was less intense but considered normal. A poorly functioning gallbladder was diagnosed in 2 per cent; while in the remaining 10 per cent, there was failure of visualization. Stones were demonstrable in 12 per cent, being observed in both normal and non-functioning gallbladders.

The question of roentgenologic diagnosis of a poorly functioning gallbladder is still controversial. In our experience it has seemed best either to repeat the examination immediately or to re-examine after a few weeks of medical regime. Most surgeons believe that cholecystectomy in these cases is indicated only where there is a typical history of biliary colic.

In a so-called non-functioning gallbladder, the question of absorption must, of course, be weighed before the organ is to be considered abnormal. Thus, an ob-

structed pylorus will not allow enough of the contrast material to enter the small intestine to permit sufficient absorption for adequate gallbladder contrast. A considerable decrease in liver function will also result in non-filling even though the gallbladder is actually normal. Again, in cases of severe heart disease, inadequate absorption and poor liver function may lead to an erroneous diagnosis of non-functioning gallbladder. However, clinical examination in such cases usually points to the inadvisability of administering radiopaque agents.

In 30 of our cases in which the gallbladder was not demonstrable, the 3-gm. dose of Priodax was repeated immediately in order to check the value of a single dose. Only one of these patients showed a normal functioning gallbladder following re-examination. This is in marked contrast to our experience with tetraiodophenolphthalein, with one out of four patients showing normal function at a 24-hour re-examination. At present, the single 3-gm. dose of Priodax is considered satisfactory in cases of non-functioning gallbladder. A second dose is administered only exceptionally, particularly where there is some question of poor function, with or without stones.

Thus far, surgery has been carried out in 60 cases of this series. In all cases where stones were demonstrable radiologically, they were found at operation. Stones were also found in one patient where the roentgen diagnosis of normal functioning gallbladder without stones had been made. In one case diagnosed as non-functioning gallbladder, surgery revealed normal function. The percentage of accuracy in this small series of surgical checks was 96.7 per cent, comparing favorably with the surgical follow-up findings after the administration of tetraiodophenolphthalein.

#### CONCLUSIONS

Priodax is a reliable contrast material for cholecystography. No evidence of harmful effects was observed in 600 cases. Nausea, vomiting, and diarrhea are con-

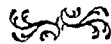
siderably less than with tetraiodophenolphthalein. Diagnostic accuracy is as great as that achieved with tetraiodophenolphthalein, and in some respects (particularly in cases of non-functioning gall-bladder) Priodax seems to be more reliable.

NOTE: The clinical trial of Priodax was made possible by the Schering Corporation, Bloomfield, N. J., which furnished the contrast material for this study.

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#### BIBLIOGRAPHY

- DOHRN, M., AND DIEDRICH, P.: Deutsche med. Wehnschr. 66: 1133-1134, 1940.  
JUNEMANN, K.: Klin. Wehnschr. 20: 125-128, 1941.  
GRUNKE, W., AND FINGER, H.: Klin. Wehnschr. 19: 1187-1189, 1940.  
MODELL, W.: J. Lab. & Clin. Med. 27: 1376-1384, 1942.  
KLEIBER, N.: Deutsche med. Wehnschr. 66: 1134-1135, 1940.  
RATING, B.: Fortschr. a. d. Geb. d. Röntgenstrahlen 63: 99-110, 1941.  
KIRKLIN, B. R.: Am. J. Roentgenol. 25: 595-601, 1931.  
KIRKLIN, B. R., AND BLAKE, T. W.: J. A. M. A. 105: 1416-1419, 1935.  
GRAHAM, E. A.: Am. J. M. Sc. 172: 625-643, 1926.



# Baker's Cyst: Posterior Herniation of the Knee Joint<sup>1</sup>

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THERE ARE numerous references in the literature to cysts of the popliteal region. Adams (1) in 1840 presented one of the first descriptions of herniation of the capsule of the knee joint. He considered the popliteal swelling to be a "dropsy" of the joint. Gruber (2) described enlarged bursae communicating with the knee joint. Foucher (3) made a study of 11 dissected specimens of popliteal cysts and 19 clinical cases. Baker (4) described 10 cases, discussed the formation of synovial cysts, and differentiated them from diseases of the knee joint. His original belief was that these cysts were the result of osteo-arthritis. In 3 of his patients examination after amputation indicated that there was a true herniation through the posterior wall of the joint capsule. He wrote: "To be a true hernia, the sac must be connected with the joint. It must be lined with synovia and connected with the joint by either a normal or abnormal opening." Haggart (7) presented 12 cases in which operation was done. Nine of these were true herniations of the knee joint; in one there was a lipoma of the popliteal space, in another a hyperplastic subcutaneous fat pad, and the remaining patient had an enlarged semimembranosus bursa.

Wilson, Eyre-Brook and Francis (8) presented a thorough survey of the anatomical, operative, and pathological aspects of 21 cases. They made roentgenologic pneumograms in their last 3 patients and describe aspiration of the cyst and its injection with air. Cravener (5) reported a single case in which air was injected directly into the joint and demonstrated air in the cyst roentgenographically. The syndrome is fairly definite. Usually

the hernia develops insidiously. Occasionally, because of trauma or inflammation, an acute effusion occurs and the sac is pushed backward along the path of least resistance. In the early stages, there may be only vague pain and a sense of fullness, which may be intermittent. The symptoms may suggest an internal derangement of the knee. As the cyst increases in size, the swelling extends down the popliteal space, under the deep fascia.

When the patient is in the upright position and the knee is completely extended, the cystic swelling may appear as a bulging mass on the medial aspect of the popliteal area distal to the popliteal creases. Examination usually shows a soft, non-tender, fluctuant mass along the

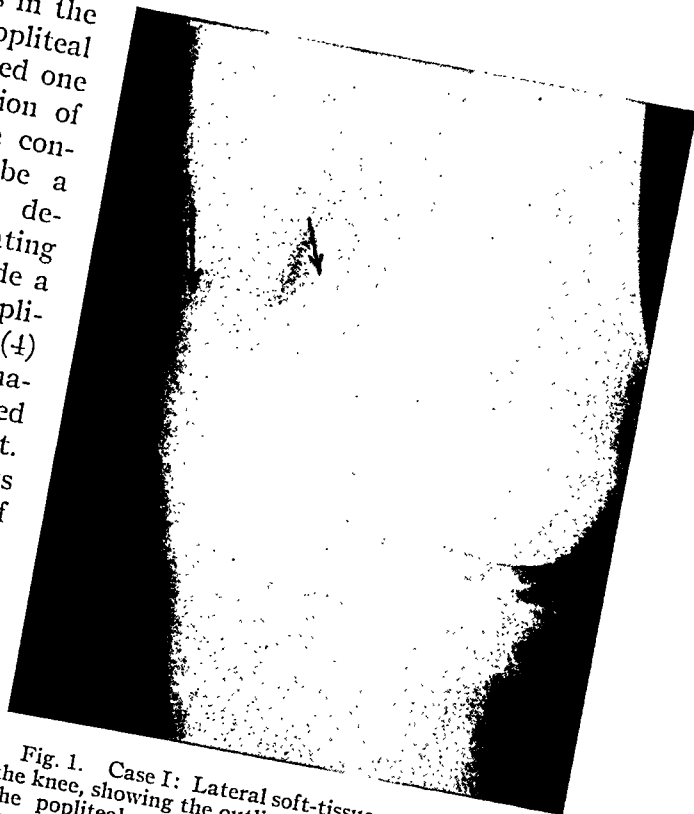


Fig. 1. Case I: Lateral soft-tissue roentgenogram of the knee, showing the outline of the superior portion of the popliteal mass (Baker's cyst). This soft-tissue mass was not visible on the anterior-posterior view. Compare with Figure 3.

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Figs. 2 and 3. Case I: The anterior-posterior view (left), made after air injection of the knee joint, shows the abnormal collection of air overlying the medial surface of the knee. The lateral view (right) shows the cyst filled with air. The multiloculated character is obvious. The air-filled stalk of communication with the knee joint is not so clearly demonstrated as in Figure 4.

lateral aspect of the semimembranosus tendon. This cyst must be differentiated from a number of other entities, including lipoma, hyperplastic bursitis, fibrosarcoma, angioma, and arteriovenous aneurysm.

The purpose of this report is again to call attention to the method of pneumographic diagnosis. In many patients who are suspected of having a popliteal cyst a definite diagnosis can be made by pneumograms of the knee joint. Plain soft-tissue roentgenograms will usually show the abnormal swelling but will not demonstrate its communication with the joint (Fig. 1).

The two cases to be reported here were satisfactorily diagnosed by the following method.

The skin over the anterior aspect of the knee is prepared in the usual aseptic manner. A two-way stopcock is attached to a No. 18 or 20 needle and syringe in such a manner that air filtered through a sterile sponge can be drawn into the syringe. The tip of the needle is then introduced into

the knee joint on its anteromedial aspect. Sufficient air to fill the joint can be injected with safety. After the injection, the needle is withdrawn and an elastic cloth bandage is applied to the lower third of the thigh and the knee, compressing the quadriceps pouch. This produces an even distribution of the air, which should enter any cyst communicating with the joint, unless the point of communication is blocked. Roentgenograms with soft-tissue exposure are then made (Figs. 2, 3, and 4). If the films fail to show air in the popliteal swelling, then aspiration of the cyst should allow the air to replace the gelatinous material.

The treatment, as advocated by Baker (4) and improved by Haggart (7) and Wilson *et al.* (8), is palliative or surgical. If the cyst is small and symptoms have been mild, a tight binder with pressure pad directly over the mass is said to minimize the possibility of a recurrence of the swelling. If the cyst has become large and

painful, impinges upon the tibial nerve, causes edema of the leg by obstructing venous return, interferes with the arterial flow, or hinders normal motion of the knee, then surgical removal is advisable. Injection of a sclerosing material into any cyst or popliteal swelling is contraindicated because of the potential danger of injuring the knee joint.

### CASE REPORTS

CASE I: G. B., a 28-year-old white female, was seen in consultation in regard to intermittent swelling over the posterior aspect of the left knee, of eighteen months' duration. Examination showed a slight increase of joint fluid without tenderness. Motion was present from  $180^{\circ}$  to  $45^{\circ}$ . On the posterior surface of the knee there was a soft, non-tender, fluctuant mass,  $3 \times 4$  cm., in the mid-line just inferior to the popliteal skin creases. Ballottement of the patella produced a palpable fluid wave in this mass. There was no increase in skin temperature or bruit.

Roentgenograms made after injection of air into the knee joint showed the mass to be a large, multi-loculated cyst (Figs. 2 and 3).

Operation was advised but was refused.

CASE II: E. R., a 4-year-old boy, was seen because of recurrent swelling over the posterior aspect of either knee, of eight months' duration. These swellings, which were asymptomatic, varied in size. During the two months prior to hospital entry, the mass on the left knee had disappeared completely, but the one on the right had remained about the same size. Examination showed a soft, fluctuant, non-tender, cystic mass, 2 cm. in diameter, on the posterior aspect of the right knee overlying the tendon of the semimembranosus muscle and inferior to the popliteal skin creases. On extension of the knee, the swelling became tense and moved with the medial gastrocnemius tendon. The overlying skin appeared normal. The left knee showed no abnormality.

Thirty c.c. of filtered air were injected into the right knee joint by the method described above. Roentgenograms showed the synovial space to be well formed. There was an abnormal collection of air in the popliteal region, in what appeared to be a localized cyst communicating with the joint by a slender stalk (Fig. 4). On aspiration of the cyst, gelatinous material and air were obtained.

At operation the cyst was found to lie underneath the popliteus muscle and along the gastrocnemius tendon, to which it was adherent. The cyst was freed from the tendon and on reflection of the popliteus muscle was found to connect directly with the knee joint by a long slender pedicle, which was dissected into the knee joint and severed at that level.

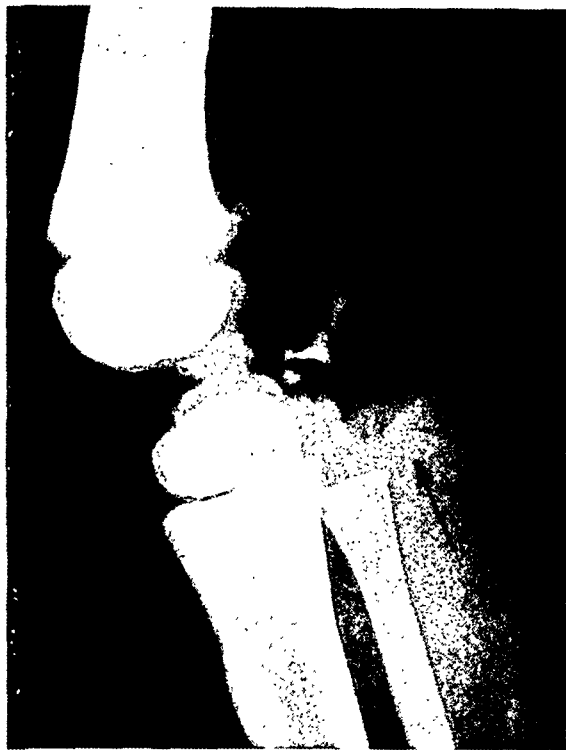


Fig. 4. Case II: Lateral view showing the cyst filled with air. The abnormal collection of air in the popliteal space can be seen to communicate directly with the posterior joint by the thin stalk.

### DISCUSSION

Pneumograms of the knee joint are indicated in all cases of abnormal popliteal swellings where cysts communicating with the joint are suspected.

During operation for the removal of a popliteal cyst or herniation, any pedicle which is demonstrated should be followed into the knee joint and severed through its intra-articular portion. A complete closure of the capsule should be carried out. If this is done, the possibility of recurrence should be minimized.

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### BIBLIOGRAPHY

1. ADAMS, ROBERT: Chronic Rheumatic Arthritis of Knee Joint. *Dublin J. M. Sc.* 17: 520, 1840.
2. GRUBER, WENZEL: (a) Über die Ausstülpungen der Synovialkapsel des Kniegelenkes und über die chirurgische Wichtigkeit der Communication derselben mit einigen benachbarten Schleimbeuteln. *Vierteljahrsschr. f. d. prakt. Heilk.* 5: 95-105, 1845.  
(b) Hygrom der Bursa mucosa genualis retro-condyloidea interna s. semimembranoso-gastrocnemialis. *Oesterr. Ztschr. f. prakt. Heilk.* 15: 961-964, 1869.

(c) Hygroma von enormer Grösse an der Bursa genu mucosa retro-condyloidea interna. Virchows Arch. f. path. Anat. 99: 489-492, 1885.

3. FOUCHER, E.: Mémoire sur les kystes de la région poplitée. Arch. gén. de méd. 2: 313, 1856.

4. BAKER, W. M.: On the Formation of Synovial Cysts in the Leg in Connection with Disease of the Knee Joint. St. Bartholomew's Hosp. Rep. 13: 245-261, 1877.

5. CRAVENER, E. K.: Hernia of the Knee Joint. J. Bone & Joint Surg. 14: 186-187, January 1932.

6. SNODGRASS, L. E.: Compound Cystic Bursitis of the Knee Joint. J. Bone & Joint Surg. 18: 229, January 1936.

7. HAGGART, G. E.: Posterior Hernia of the Knee Joint: a Cause of Internal Derangement of the Knee. J. Bone & Joint Surg. 20: 363-373, April 1938.

8. WILSON, P. D., EYRE-BROOK, A. L., AND FRANCIS, J. D.: Clinical and Anatomical Study of Semimembranosus Bursa in Relation to Popliteal Cyst. J. Bone & Joint Surg. 20: 963-984, October 1938.



# Low-Voltage Contact Irradiation Therapy: Further Experience<sup>1</sup>

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IN A PREVIOUS communication (1) the basic principles of contact irradiation therapy were indicated, with an outline of possible uses for this particular method of treatment. After a lapse of nearly five years, during which period contact therapy has been constantly employed, it may be useful to review briefly these basic principles and to enumerate the pathologi-

(2) a consequent absorption of a large amount of energy in the first few centimeters of tissue. These conditions are met by the apparatus which we have employed, the Philips Metalix contact therapy unit, operating at 50 kv. constant potential, 2 ma. of current, and an anode surface distance of about 2.0 cm. The filtration varies from none at all to 2.5

TABLE I: PERCENTAGE DEPTH DOSE (H<sub>2</sub>O)  
Voltage, 50 kv. (constant potential). Current, 2 ma. Field, 2.5 cm..

Distance	Filter	Depth Dose			
		0.0 Cm.	1.0 Cm.	2.0 Cm.	3.0 Cm.
2.0 cm.	0.0	100%	22%	7.8%	3.5%
2.2 cm.	1.0 mm. Al	100%	33%	13.5%	6.5%
2.2 cm.	2.5 mm. Al	100%	37%	17.5%	8.4%
4.0 cm.	0.0	100%	30%	13%	6.9%
4.2 cm.	1.0 mm. Al	100%	45%	25%	13.5%
4.2 cm.	2.5 mm. Al	100%	51%	30%	18.0%

TABLE II: INTENSITY OF RADIATION  
Voltage, 50 kv. (constant potential). Current, 2 ma. Field, 2.5 cm.

Distance	Filter	Intensity in Air r per minute	Back-Scatter	Half-Value Layer
2.0 cm.	0.0	7,400	6.0%	0.2 mm. Al
2.2 cm.	1.0 mm. Al	1,278	9.0%	1.0 mm. Al
2.2 cm.	2.5 mm. Al	506	10.5%	1.4 mm. Al
4.0 cm.	0.0	1,850	6.5%	0.2 mm. Al
4.2 cm.	1.0 mm. Al	350	10.0%	1.0 mm. Al
4.2 cm.	2.5 mm. Al	139	12.0%	1.4 mm. Al

cal conditions in which it has been found most useful, together with the results obtained.

It is doubtful that the effect of radiant energy depends on its wave length. It seems likely (particularly in the light of the experience herein set forth) that it depends upon the total energy absorbed per cubic centimeter of tissue and the time spacing of the doses or the fractionation of the total energy.

The essential conditions to be fulfilled are: (1) a short distance between the surface and the source of the radiation and

mm. Al, with 1.0 mm. Al being most frequently used. The percentage depth dose and the intensity of the radiation are shown in Tables I and II.

The tube used is constructed with a metal sheath, is rayproof and shockproof, and has a high-tension connection only to the anode, the cathode side being grounded. It is cooled by an air blower. It is cylindrical in shape and measures 23.7 inches in length, with a diameter at its distal end of 1.18 inches. It is, therefore, easily introduced into body cavities and into surgical incisions. The radiation emerges axially, passing through a glass window

<sup>1</sup> Accepted for publication in July 1943.

and a protective cap of a plastic material having a total inherent filter value of 0.2 mm. Al. The anode-surface distance is 18 mm. The tube is used for the most part with a rubber covering, which adds 2.0 mm. to the distance, and if filters are employed the total anode-surface distance becomes 22 mm. From this extremely short anode-surface distance there result an extraordinarily high r-per-minute afflux and a spatial distribution of the radiation closely resembling that of radium. Because of the low voltage employed, the radiation is of long wave length, the quality being represented by a half-value layer in aluminum of 0.2 mm. if no added filter is employed, and 1.0 mm. if 1.0 mm. Al is added. Additional filtration does not result in marked hardening, 2.5 mm. Al added producing a half-value layer in aluminum of 1.4 mm. With this filtration the beam becomes practically homogeneous and cannot be further hardened.

The technical factors regularly employed are 50 kv. constant potential and 2 ma. current. The radiation may be filtered by 1.0 or 2.5 mm. aluminum and the anode-surface distance may be varied somewhat. The distance with no filter is 18 mm. and the radiation intensity is 7,420 r per minute. Note that the filter thickness is 2.0 mm.; it is the equivalent value in aluminum that is expressed as 1 mm. With 2.5 mm. Al the r output decreases to 506 r per minute. Localizing cylinders are supplied, and one of these has a metal cuff which serves to increase the anode-surface distance to 42 mm. At this distance the r afflux becomes 350 r per minute with an equivalent filtration value of 1.0 mm. Al and 139 r per minute with 2.5 mm. Al. These localizing cylinders are placed over the area to be treated—one being chosen of such size that the lesion fits within the opening—and the tube is introduced into the cylinder. These cylinders may be sterilized and introduced into body cavities and through surgical wounds. The tube may be used in its support on the unit or it may be held with impunity in the operator's hand. Greater distances

than 42 mm. may be employed, of course, after the r at the surface have been measured. In fields above 5 cm. in diameter, however, the distribution of the radiation becomes very uneven at the edges, and such fields must be marked off rather carefully.

It may be stated as axiomatic that successful radiation therapy contemplates a maximum of damage to the tumor cells and a minimum injury to the surrounding normal structures. The combination of soft radiation and an extremely short anode-surface distance which obtains in contact therapy permits close approximation to this ideal, since in general the tumor tissue is in contact with the source of radiation while the adjacent tissues are protected by the laws of geometry. A glance at the depth dose table (Table I) and the figures for back-scatter (Table II) will make this point clear. With no added filter and with a total anode-surface distance of 20 mm., the depth dose at 2 cm. is only 7.8 per cent and the back-scatter at the surface is 6 per cent. With 2.5 mm. Al added filter (the heaviest filter employed) and at an anode-surface distance of 42 mm. (generally speaking, the maximum distance), the depth dose at 2 cm. is 30 per cent and the back-scatter at the surface is 12 per cent. Safeguarded by these factors, the patient may be given unusually large total doses of radiation with impunity.

It will be noted that extremely large doses of irradiation have been employed in many of the cases described. It is extremely important to realize that these doses cannot be reproduced with impunity using conventional low-voltage therapy. Indeed, it is quite likely that we are dealing here with a different value for the roentgen. Certainly, just as gamma roentgens cannot be added to the computed dose of high-voltage roentgen therapy, the doses herein described cannot be considered as identical with like doses in roentgens when other types of roentgen therapy are employed.

A practical indication of this is in the reactions which occur. In general, it may be said that the reactions appear

somewhat earlier than with conventional therapy; that they are less painful than the usual reactions; and that an exudative epidermitis characterizes the reactions following the larger total doses. Changes in the tumor are commonly noted before the end of the treatment series. The total dose must be determined by the behavior of the tumor rather than by a fixed plan of treatment, but in any case one should endeavor to administer 3,000 to 4,000 r to the tumor base. The cosmetic results are very satisfactory.

One must remember, also, that the very factor which permits the administration of such relatively large doses of radiation, *i.e.*, the extremely low depth dose, prevents the successful use of contact therapy in the treatment of deep-seated lesions. The surgeon, observing the excellent results obtained in suitable cases, will frequently suggest the application of the method to carcinoma of the prostate, or to treatment of parametrial fields in cervical or uterine carcinoma. Contact therapy has no place whatever in the treatment of these or similar conditions and it should never be employed.

The ensuing discussion will serve to indicate the type of lesion which has been found most suitable for treatment, the technic employed, and the results.

#### PAPILLOMA

Twenty patients with papillomata were treated: All of these were on the feet and toes; some were multiple. The number of treatments varied from one to four, elapsed time from one to thirty-eight days, and the dose (measured in air in all doses given) from 1,146 to 3,428 r. Most patients received doses in the neighborhood of 2,500 r. There was no particular reason for the rather wide variation in time and dosage. At present three doses of 800 to 1,000 r are given in a period of eight to ten days. The filtration was 1.0 mm. Al in all cases. Nineteen of the patients were cured and one reported improvement but failed to return for more treatment.

#### KERATOSES

Twelve cases of keratosis were treated, of which 10 were cured and 2 were unimproved. One of the 2 unimproved cases had the largest dose (5,112 r in sixteen days) given. All of the others had doses of approximately 2,500 r, and the elapsed time (which ranged between three and sixteen days) averaged five days. The filtration was 1.0 mm. Al in all cases except 2, in which no filter was used.

#### KELOIDS

Only a small percentage of keloids will be suitable for contact therapy, namely, those which are less than 3 cm. in their greatest diameter. Very thick keloids, regardless of size, had better be treated with higher-voltage radiation, since the depth doses obtained in contact therapy are very low. Nine patients were treated. One of these received 402 r immediately after excision of a keloid as a prophylactic measure, and the result is impossible to evaluate. In the other 8 cases the filtration was 1.0 mm. Al in 5 cases, 2.5 mm. Al in 2 cases, and none in one case. The presence or thickness of a filter seemed to make little or no difference in the result obtained. The dose was from 1,518 to 3,438 r (3 cases) and the number of treatments ranged from three to nine. Five cases were cured and 3 sufficiently improved to satisfy the patient.

#### HEMANGIOMA

All of the hemangiomata treated were the small superficial tumors so common in babies. None was of the cavernous type, which requires quite different treatment. The best results are obtained in those lesions which blanch easily under pressure. These patients are commonly treated with radium, but the simplicity, ease of application, and brief time required for treatment make contact therapy the method of choice.

When we first began to treat hemangiomata by contact therapy, we gave rather large doses, as high as 3,500 r over a period of two weeks. The results were satis-

factory, but fairly sharp reactions occurred, with crusting, and our present method is to use much smaller doses, 800 to 1,000 r given over a period of three months. Cosmetic results are better and no appreciable reactions are observed. Forty-one patients were treated (some of them had multiple hemangiomas) with complete disappearance of the lesion in 39. The lesions were located on the face, scalp, lips, abdomen, vulva, buttocks, toes, and eyelids. One case serves so well to illustrate the value of the method that it is worth while to describe it in detail.

A baby, three months old, had never been able to open its right eye because of a bulky hemangioma on the conjunctival surface of the upper lid. Under chloroform anesthesia the lid was everted and 744 r, half-value layer 1.0 mm. Al (1.0 mm. Al filtration), was administered. One month later the child could open the eye and it was possible to evert the lid without anesthesia. At that time 500 r (quality as above) were given and the tumor has entirely disappeared. One can easily understand the difficulty of treating this lesion with radium.

In the 41 cases reported the number of treatments varied from one to six. In 2 cases no filter was employed, but 1.0 mm. Al was used in all others. The elapsed time was from one to eighty days and the dose ranged between 572 and 3,448 r. At present we give 250 r per dose, repeating it three or four times in three months.

#### VAGINAL CARCINOMA

In vaginal carcinoma our experience has been uniformly bad, probably because the lesion is not so superficial as it appears to be, but infiltrates so deeply that an adequate dose cannot be delivered at the base of the tumor. All of our patients are dead, and we observed no improvement after contact irradiation.

#### CARCINOMA OF THE BLADDER

Some of the cases of carcinoma of the bladder here mentioned have been reported elsewhere (2), but since one of the most

useful fields of application of contact therapy is in the treatment of this disease, it seems worth while to include them in this report. Twenty-four cases were treated prior to Jan. 1, 1943. Our first 3 cases were treated after marsupialization of the bladder, and these received from ten to twelve treatments each. All others have been treated by reopening the bladder for each application of contact therapy. Two patients received one treatment, 1 had four treatments, 6 were treated three times, and the others twice. Both infiltrating and papillary tumors were treated, the criterion being a tumor less than 3.0 cm. in diameter and without demonstrable metastases. Of the 24 patients included in this report, 5 are dead of causes other than carcinoma. Autopsies were done on 4 of these, and no evidence of cancer was found. Three have died of cancer, and 16 are living without evidence of malignant growth. In every case a filter of 1.0 mm. Al was employed. The dose ranged from 5,730 to 30,672 r. It is now fairly well standardized at 10,000 r given in two treatments, with seven or eight days intervening.

#### EPITHELIOMA OF THE LIP

The accessibility of the lesion and ease of application of the treatment make contact therapy the ideal method in the treatment of those lip cancers which involve the vermilion border and have not deeply infiltrated the muscular tissues. Bulky, infiltrating tumors are best treated with intramural radium and high-voltage therapy. Nineteen cases are here reported, all squamous-cell epithelioma of the lower lip. One patient had regional lymph node involvement, and the nodes were treated with high-voltage radiation. The smallest dose given was 4,472 r; the largest was 8,022 r. Most cases received about 5,500 r. The treatment time was from eight to seventeen days. A thin piece of lead foil should be placed behind the lip and held away from the gingival tissue by a cotton dental roll, thus avoiding a painful reaction on the gums. Of the 19 patients,

treated, 1 is dead, 1 is living but with a local recurrence, and 17 are living without evidence of cancer for periods of from one to five years.

#### INTRA-ORAL CANCER

Because intra-oral cancer is a rather broad generic term including several malignant tumors (which behave somewhat differently in their response to irradiation), and because nearly all of the 21 patients in this group had high-voltage therapy and radium needle or radon seed implantation, it seems impossible to evaluate the role of contact therapy. The interior of the mouth is accessible, and certainly it would seem that the application of 5,000 to 6,000 r of radiant energy directly to the tumor would increase the likelihood of cure. It is our impression that it has done so.

#### EPITHELIOMA OF THE SKIN

As one would expect, cutaneous epithelioma is most amenable to contact therapy. These lesions are, of course, cured by other types of therapy, but the brief treatment times and the simplicity of application, combined with the excellent results obtained, commend the method to the busy therapist.

Fifty-seven cases were treated with 3 recurrences and a single death from metastases. Fifty-three patients have clinical

cures over periods of from one to five years. The number of treatments varied from one to ten, but nearly all cases received three, four, or five treatments. The filtration was none (1 case), 1.0 mm. Al (53 cases), and 2.5 mm. Al (3 cases). The use of a filter of 1.0 mm. Al (half-value layer 1.0 mm. Al) is economical, and the results seem no different. Dosage was from 3,000 to 9,000 r, most patients receiving about 5,500 r. The elapsed time was one to sixteen days, ten days being the total time most commonly employed.

#### CONCLUSIONS

1. Contact radiation therapy is a method of great usefulness in a comparatively limited group of cases.
2. Large doses may be given safely because of the geometrical laws protecting underlying tissues.
3. These large doses must not be given with other types of roentgen therapy, and the doses in roentgens here stated are to be applied only to contact therapy.

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#### REFERENCES

1. GOIN, LOWELL S., CROSSAN, JOHN W., AND JELLEN, JOSEPH: Low-Voltage Contact Roentgen Therapy (Chaoul Therapy). *Radiology* 36: 583-587, May 1941.
2. GOIN, LOWELL S., AND HOFFMAN, EUGENE F.: Use of Intravesical Low-Voltage Contact Roentgen Irradiation in Cancer of the Bladder. *Radiology* 37: 545-548, November 1941.





# Treatment of Osteogenic Sarcoma with Preoperative Roentgen Radiation in Large Doses<sup>1</sup>

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THE TREATMENT of osteogenic sarcoma has been very unsatisfactory even in the hands of the most qualified. In many of the best clinics in the country the treatment of choice has been, and still is, early surgery. The results have been poor and many studies of the problem have been carried out to see if improved methods could not be found.

In 1931, the author, while a fellow in Memorial Hospital, New York, studied 112 cases of osteogenic sarcoma covering the period from 1919 to 1931. These cases were treated in a variety of ways and it was hoped that the study would reveal that method which was yielding the best results. No such method was found. Roentgen radiation alone, however, had not been tried as the treatment of choice. When it was used, the amount was too small for therapeutic effect. This probably was based on the feeling that delay was contraindicated so that time was not allowed for a sufficient dose and for the radiation effect to become established.

Ferguson (1) reviewed 400 cases in the Registry of Bone Sarcoma of the American College of Surgeons and reported that early surgery gave the poorest results. He also found that radiation alone did not effect a single cure.

Higinbotham and Coley (2) conclude that in some patients, notably adults with radioresistant tumors, immediate amputation is the treatment of choice. They also state that some osteogenic sarcomas are somewhat radiosensitive and that these should be treated by carefully planned preoperative irradiation followed by surgery.

<sup>1</sup> From the Department of Therapeutic Radiology, Cook County Hospital, Chicago, Ill. Presented before the Radiological Society of North America, at the Twenty-eighth Annual Meeting, Chicago, Ill., Nov. 30-Dec. 4, 1942.

The series to be recorded is not large, but we feel that the consistently good results following the method used justify a preliminary report at this time.

The method of treatment consists in a long protracted series of high-voltage x-ray treatments using 200 kv.p., 0.5 mm. copper + 1.0 mm. aluminum filter, H.V.L. 0.9 mm. copper, S.T.D. 60 to 70 cm. Multiple ports over the lesions are treated, one port daily, with 250 to 300 r measured in air. Sixty to one hundred and forty treatments are given. Amputation is done when the first signs of radiation necrosis are noted.

## CASE REPORTS

CASE 1: D. T., age 11, was referred for x-ray therapy in May 1936. The diagnosis was osteochondrosarcoma of the right tibia. Seventy-seven high-voltage x-ray treatments were given from June 2, 1936, to Sept. 24, 1937. Amputation was performed Oct. 18, 1937. The patient is well and active at the present time, going to high school, six and a half years after the initial diagnosis.

CASE 2: T. G., a chef, age 37, was first seen in September 1936, with a history of having been under a physician's care for neuritis of the right shoulder for six months. No roentgenogram had been taken. Roentgen examination on admittance showed an osteogenic sarcoma of the upper third of the humerus. The patient refused surgery and was referred for x-ray therapy. He received 129 x-ray treatments from Oct. 2, 1936, to Oct. 15, 1937. A small area of necrosis developed in October 1937. This process could not be checked and finally, in June 1938, Dr. J. J. Callahan did a shoulder girdle amputation. Microscopic examination showed an osteoblastic sarcoma of the humerus infiltrating the scapula, with myxomatous degeneration. Thus, even with the large amount of radiation given in this case there still remained viable tumor cells. This patient is living and well today, in active business, seven years after the onset of symptoms.

CASE 3: E. K., age 13, was first seen in December 1936. A diagnosis of osteogenic sarcoma of the upper half of the ulna had been made by roentgenograms and biopsy elsewhere, and 4 low-voltage x-ray treatments to the shoulder and 4 to the forearm had

been given. The patient was not seen again until June 21, 1937. In the meantime he had received several injections of serum at a clinic in Detroit. From June 21, 1937, to July 15, 1938, he received 82 high-voltage treatments. A mid-humeral amputation was done July 22, 1938. Microscopic study of the surgical specimen showed a fibrochondrosarcoma. When last seen, in May 1942, the patient was objectively in good health, working every day, and had recently been married. Films of the chest show a slowly growing metastatic process in the right lung.

CASE 4: R. H., age 15, had an osteogenic sarcoma of the distal portion of the right femur with a pathological fracture. He received 60 high-voltage x-ray treatments to the involved area from Feb. 13, 1937, to Jan. 28, 1938. A right hip disarticulation was done April 30, 1938. When last seen, in May 1942, the patient was getting around, well and happy. He had no evidence of metastasis.

CASE 5: H. M., age 26, was first seen at the University of Michigan, where a roentgenographic diagnosis of osteogenic sarcoma of the distal end of the right femur was made and biopsy, to be followed by immediate surgery, was recommended. She received 137 high-voltage x-ray treatments from Nov. 30, 1939, to July 13, 1940. Hip joint disarticulation was done Sept. 8, 1941. The patient is living and well and has shown no evidence of metastases to date.

CASE 6: A. J., age 40, received 90 x-ray treatments from May 23, 1940, to Nov. 1, 1940, for an osteogenic sarcoma of the upper portion of the left tibia. Mid-thigh amputation was performed on Sept. 8, 1941, sixteen months after the patient was first seen. He is in excellent health at the present time.

We have at present two cases under treatment.

CASE 7: J. M., age 43, has an osteogenic sarcoma of the acromion process of the left scapula. He was first seen on June 4, 1941, since which time he has received 57 high-voltage x-ray treatments. A necrosis developed, which is now healing nicely. The patient is in excellent health and has no evidence of metastasis.

CASE 8: Dr. A. O., age 31, has an osteogenic sarcoma of the middle third of the right femur. He has had 140 high-voltage x-ray treatments from March 6, 1942, to the present time. As of this date, May 10, 1943, a small area of necrosis has developed near the site of the lesion. There is no evidence of metastasis.<sup>2</sup>

#### CONCLUSIONS

Based upon the clinical experience of the past twelve years and the results ob-

<sup>2</sup> Hip joint disarticulation was performed May 24, 1943.

tained in this series of cases, our present thoughts concerning the treatment of osteogenic sarcoma may be summed up as follows:

1. Osteogenic sarcoma cannot be controlled entirely by radiation alone or by surgery, but surgery following heavy irradiation gives the best prognosis.

2. All osteogenic sarcomas should be considered radioresistant and treated with a long protracted course of irradiation. The response of the lesion should be watched by serial roentgenograms, and if recession of the tumor occurs, indicating a radiosensitive lesion, the total amount of radiation may be scaled down so that subsequent amputation may perhaps be avoided. Otherwise irradiation should be continued, well beyond the point usually considered as a tissue tolerance dose. Surgery should be withheld until the first evidence of radiation necrosis appears, but not delayed beyond this point, as secondary infection occurs, which handicaps the surgeon.

3. Osteogenic sarcoma of bones other than those of the extremities should be treated more conservatively, as severe radiation necrosis can become symptomatically as disabling as the primary disease.

4. The delay of amputation involved in the prolonged series of x-ray treatments does not increase the likelihood of distant metastases. If metastasis is manifest within six months after the beginning of therapy, the process had occurred before any treatment was administered.

5. Biopsy is contraindicated in all instances. Usually the roentgenogram is diagnostic. If the serology is negative and there is any question, x-ray therapy may be employed as a therapeutic test.

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#### REFERENCES

1. FERGUSON, ALBERT B.: Treatment of Osteogenic Sarcoma. *J. Bone & Joint Surg.* 22: 92-96, January 1940.
2. HIGINBOTHAM, NORMAN L., AND COLEY, BRADLEY L.: Methods and Effects of Preoperative Irradiation in the Treatment of Osteogenic Sarcoma. *Am. J. Roentgenol.* 47: 902-907, June 1942.

## DISCUSSION

**James J. Callahan, M.D. (Chicago, Ill.):** My interest in this subject dates back a number of years, as we have had the good fortune, or misfortune, of seeing many osteogenic sarcomas. In as large a fracture ward as we have at the Cook County Hospital, Dr. William R. Cubbins, Dr. Carlo Scuderi, and I have an opportunity to see and treat these tumors.

We became interested after following the usually accepted routine of biopsy, amputation, and radiation, but I do not remember any patients treated in this manner who are still alive. In one case where biopsy was performed there was a question of diagnosis, but by the time the biopsy diagnosis was returned, another roentgenogram of the involved limb showed the process to have extended three-fourths of an inch in comparison with the previous films. A disarticulation of the limb was done, with a ligature at the common iliac, and many nodes were found to be present. These were removed and sectioned, and a definite diagnosis of sarcoma was made. This patient lived one year. Another patient receiving the same form of treatment was a man 33 years of age, with a questionable tumor above a recent fracture. Biopsy proved this to be a sarcoma. A disarticulation of the shoulder was performed, followed by roentgen irradiation, and the patient expired within a year. These are just two of the many poor results that we experienced with the recognized treatment.

Not being satisfied with our results, we consulted with Dr. Robert McNattin. In the past seven years we have referred all of our malignant cases to the therapy department, where after careful x-ray study they were treated with massive doses of x-radiation, followed by amputation. At the present time I do not know of any patient so treated who has died. Yet all those in whom biopsy was performed, followed by intensive radiation, are dead.

There are a few points that I think are essential in the care and treatment of osteogenic sarcoma. First, the diagnosis. Many times, as Doctor

McNattin has brought out, it is impossible to state definitely that this or that lesion is a sarcoma. If, however, after a period of treatment the case fails to respond, it is not too late to perform a biopsy. Second, in patients where an amputation or disarticulation is anticipated, one must be very careful that the skin is not injured, so that secondary infection occurs. This definitely handicaps the surgeon and requires a wider excision than is normally necessary. In one case in which I disarticulated a shoulder, it was necessary to excise the area where therapy had caused necrosis. The approximation of the skin at closure failed by about 2 in., so that counter-incisions were necessary. In spite of the deep irradiation, the skin healed after a protracted period of time.

From my point of view, which is that of a surgeon, I believe that preoperative roentgen irradiation followed by amputation is without doubt the best treatment in our hands, and until a better method is devised, I shall continue to treat osteogenic sarcomas in this manner.

**John T. Murphy, M.D. (Toledo, Ohio):** I cannot let this paper go unchallenged. There is no such thing as a positive diagnosis of a malignant bone tumor with the x-ray. Certain osteogenic tumors will be cured by amputation alone. These are in the minority, but they will be cured. I have no objection to Doctor McNattin's method of treatment. I have used it myself. But it is to be borne in mind that the life history of a true osteogenic sarcoma is only about nine months after its discovery, so that with this method the patient will be dead before treatment is completed.

**Doctor McNattin (closing):** I believe that the diagnosis of osteogenic sarcoma can be made roentgenographically and, on the basis of such a diagnosis, should be treated radiologically, with subsequent surgery when indicated. I am strongly against surgical biopsy of bone tumors. If there is any biopsy done of any tumor, I would use an aspiration or needle plug biopsy.

# Theories on the Effectiveness of Roentgen Therapy in Inflammatory Conditions<sup>1</sup>

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LEOPOLD FREUND, who first used x-rays for therapeutic purposes (1897), was also the first to report the disappearance of inflammatory symptoms after x-ray treatment (1904). Thus, following irradiation for diseases of the hair, such as sycosis, the furuncles so often accompanying that condition cleared up without further treatment. As a rule, however, an exacerbation of the inflammatory symptoms, such as edema and suppuration, was observed before the hair fell out. This gave rise to the assumption that irradiation invariably leads to a greater or less increase of an inflammatory process, and the conclusion was drawn that the presence of inflammation is a contraindication to radiotherapy.

Although observations to the contrary were repeatedly published, this attitude generally prevailed up to 1924, when Heidenhain and Fried, and also Pordes, reported their results, about which Holzknecht informed American radiologists in 1926. Since that time it has been known that x-rays are able to exert a favorable influence on inflammatory conditions even in the most acute stage, provided very small amounts are given. A dose of moderately filtered rays ranging between 50 and 150 r has proved to be highly effective in a very large number of inflammatory conditions. Besides the smallness of the dose, the rapidity of the response is the most striking feature of this method of treatment. Within a matter of hours an appreciable alleviation often occurs and the infection clears up entirely in a few days.

It is especially the inflammations caused by pyogenic bacteria which have proved highly amenable to radiation therapy.

The following conditions are at present regarded as promising favorable results:

(1) Streptococcic and staphylococcic inflammations, such as furuncles, carbuncles, cellulitis, lymphadenitis, lymphangitis, erysipelas, tonsillitis, periodontitis, mastitis, thrombophlebitis.

(2) Gonococcic inflammations, such as epididymitis, prostatitis, salpingitis, parametritis, arthritis.

(3) Pneumococcic inflammations, such as bronchopneumonia, lobar pneumonia, and pneumonia with delayed resolution.

(4) Meningococcic inflammations, such as cerebrospinal meningitis.

Several theories have been launched to explain the efficacy of rays in inflammatory conditions, the results being variously attributed to the effects on the microorganisms, on the blood, on the inflammatory exudate, and on the blood and lymph vessels.

## EFFECT ON MICROORGANISMS

In the early days of radiotherapy, when the action on the tissues was not yet sufficiently understood, the simplest explanation of the effect of x-rays on inflammations appeared to be that it killed the causative agents. This conception was shaken when bacteria and other microorganisms proved to have extremely little radiosensitivity. Only enormous doses were able to destroy them *in vitro*, as shown by the experiments of Wolfenden and Ross, Muskatblit and Ouspensky, and many others. It must be said, however, that although this fact renders the theory in question unlikely, it does not prove it impossible, for tumor cells also require enormous doses for destruction *in vitro*, though they can be destroyed by a fraction of such doses when irradiated within the body.

<sup>1</sup> From the X-Ray Department of New York University Medical College. Accepted for publication in July 1943.

There are, however, still other facts against the theory under discussion. One is that the effectiveness of the rays is without any specific character. They act in the same manner regardless of whether the inflammation is caused by streptococci, staphylococci, gonococci, or meningococci. All conditions characterized by the formation of pus appear equally amenable to irradiation. Both the dose and the subsequent course of the disease appear to be the same. From this it follows that the effect of radiation is determined not by the character of the causative agent but by that of the anatomical lesion produced in the tissues. Its decisive influence also appears from the fact that the stage in which the inflammatory process is irradiated is responsible for the final result. Regardless of the agent, there will be a retrogression of the inflammatory condition without suppuration when it is treated in an early stage, while in later stages an acceleration of pus formation results. It is also found that different doses are required when different anatomical lesions are produced by the same microorganisms. Thus, the dosage and the technic of irradiation are quite different, for example, in the exudative and the productive forms of tuberculosis. A tuberculous arthritis, tuberculous peritonitis, or tuberculous fistula may be treated in quite a different way from a tuberculous hyperplastic lymphoma, tuberculous wart of the skin, or lupus.

While the examples given demonstrate with sufficient clarity that the efficacy of radiation in inflammatory processes cannot be explained by direct action of the rays on the microorganisms, it may be added that x-rays act in the same manner on inflammations of non-bacteriogenic but of post-traumatic origin (Freund and Fukase) and on inflammations caused by chemical irritants, such as silver nitrate (Motojima).

#### EFFECT ON THE BLOOD

According to another theory, x-rays act upon inflammatory processes by stimulating the bactericidal power of the blood (Fried

and others). It is believed that an increase of the antibodies in the blood leads to the destruction of the microorganisms in the infected area. Against this theory, also, is the fact that the effectiveness of the rays shows a clear dependence on the anatomical character of the lesion and not on the causative organisms. Secondly, if the favorable radiation effect were caused by an increase of the antibodies, as is the case when a bacteriolytic or antitoxic serum is injected, it would not be necessary to irradiate the inflammatory area itself. We could produce the same effect by irradiation of any other region of the body, just as an injection can be made at any site. It can easily be demonstrated, however, that the effectiveness of the rays in inflammatory conditions is strictly limited to the area of the lesion, exactly as in the case of tumors. If, for example, a patient has furuncles in both axillae and only one side is irradiated, the irradiated region alone will be improved, while the process will continue in the untreated region. In other cases, while furuncles disappear in an area exposed to rays, they become disseminated in the non-irradiated parts of the body. The absence of any influence on the bactericidal forces of the blood appears also from the unsatisfactory results of irradiation in generalized inflammatory conditions, as in furunculosis disseminated over large parts of the body and in cases of sepsis.

#### EFFECT ON THE EXUDATE

According to a third theory, the effectiveness of radiation in inflammatory diseases may be explained by the radiosensitivity of the leukocytes forming the main part of a pyogenic process (Pordes, Desjardins, and others). The idea that the leukocytes are particularly sensitive to rays seems to be derived from the fact that following radiation therapy a leukopenia may be observed. It may be recalled, however, that as early as 1906 Schwarz, Benjamin, and others showed that, if the blood-forming tissues in the body are protected from the rays when a rabbit's

ear is irradiated, no decrease of leukocytes occurs. Daily clinical observations lead to the same conclusion. Even after very intense irradiation, as for tumors, no noticeable decline of leukocytes is found as long as the blood-forming parts of the bone marrow are not irradiated. There can therefore be no doubt that leukopenia following irradiation is the result of damage to the blood-forming tissues and not to the destruction of leukocytes in circulation. Thus, the tissues forming the leukocytes and other blood elements are radiosensitive. The leukocytes themselves, like the other blood cells, may be considered as comparatively resistant.

Concerning the leukocytes in the tissues, outside the blood vessels, one arrives at the same conclusion when an attempt is made to irradiate an abscess filled with pus and therefore containing leukocytes in almost pure culture. If the leukocytes were actually radiosensitive, the cells forming the pus would be destroyed by the rays, resorbed and carried away. An abscess could thus be made to disappear in the same manner as a tumor. Consequently, an abscess would represent a particularly excellent subject for x-ray therapy. The contrary, however, is the case. The reaction of an abscess to irradiation is practically nil and the old dictum has remained valid: *Ubi pus, ibi incide*. It may be added that, if the effect of rays were based on leukocyte destruction, their effectiveness would increase with the size of the dose. Actually, the contrary is true. As the dose is increased, the results become worse.

Apparently the radiosensitivity of the polymorphonuclear leukocytes is confused with that of lymphocytes. It is the lymphocytes which, although radioresistant in the circulating blood, have actually proved to be highly sensitive to radiation outside the vessels. Thus, it is a matter of general experience that in the normal lymph nodes as well as in granulation tissue lymphocytes can be destroyed relatively easily by x-rays. But it is the polymorphonuclears which, owing to their phago-

cytic power, play an important part in acute inflammations, while lymphocytes are more abundant the more chronic the process becomes. The effectiveness of small doses of radiation in acute pyogenic inflammations cannot therefore be explained by the action of the rays on the polymorphonuclear leukocytes, since the latter are radioresistant. Lymphocytes are radiosensitive, but they do not play an important part in acute pyogenic inflammations.

The difference in radiosensitivity between lymphocytes and polymorphonuclear leukocytes is easily understood when we consider that the latter do not possess the power of multiplication or transformation into other cells, while the lymphocytes may be to a great extent the mother cells of the granulation tissue and thus may be endowed with the power of multiplication and transformation into connective tissue.

#### EFFECT ON THE BLOOD VESSELS

A fourth theory attributes all effects produced by x-rays on inflammatory conditions to action on the blood vessels. These changes are in principle identical with those occurring in normal blood vessels after irradiation. The only difference is that in the presence of inflammation the blood vessels display an increased irritability, and for this reason changes are produced by smaller doses and in a shorter time. The changes produced by rays in the blood vessels involve the blood and lymph capillaries, the arteries, and veins.

(a) *The Blood Capillaries:* When a certain dose of radiation is given, definite changes are produced in the endothelial cells, which eventually lead to a dilatation of the lumen and an increased permeability of the walls of the capillaries. Subsequently more blood flows in and permeates the walls, leading in the first place to a transudation of serum and then to an emigration of blood cells.

From the radiobiological point of view capillaries in a state of inflammation look as if they had but recently received an ery-

thema dose. Irradiation causes primarily an accentuation of the inflammatory process, as is the case when heat is applied. Strange as it may seem, the increase of inflammation actually proves beneficial, apparently because the edema produced by the inflammatory agent is often not sufficient to overcome the infection, probably because it is spread over too large an area.

Post-irradiation increase of the edema in the inflamed area has manifold direct and indirect effects. First, owing to the increased permeability of the walls, a greater amount of serum passes from the blood capillaries to the tissues. This entails an increased passage of antibodies which have been formed under the influence of the toxic agent. Thus, an increased passage of agglutinins, precipitins, bacteriolytins, antitoxins, opsonins, and all kinds of enzymes takes place, causing a detoxication of the inflammatory process. The increased flow of antibodies equals, serologically, an injection of an antibacterial or antitoxic serum. The effect may be compared to the phenomenon described by Schultz and Charleton in scarlet fever. When 1 c.c. of an antitoxic serum is injected in that condition intracutaneously, a blanching of the inflamed area results. Irradiation does not cause an increase of the antibodies in the blood of the patient but leads to a concentration of the antibodies in a definite area and for a definite time.

The radiation edema caused by the increased permeability of the capillaries brings about, beside the increased passage of antibodies, an increased passage of normal blood cells, such as lymphocytes, monocytes, and leukocytes from the blood stream to the inflamed area. These cells are endowed with the power of phagocytosis. In the course of the ensuing process, necrotic tissue debris and lifeless tissue, such as fibrin or calcified deposits, can be resorbed by the phagocytic elements.

The second main effect resulting from the increased edema following irradiation is the increase of tension in the inflamed

area. This can frequently be noticed clinically as an increased swelling and is felt by the patient because it is associated with increased discomfort and pain. The symptoms are apt to suggest an exacerbation of the inflammatory process. Actually, they mark clinically the beginning of the radiation effect and are to be regarded as an indication that the dosage was adequate. The most important consequence of the increased tension in the irradiated area is the opening of the lymphatic capillaries, the mechanism of which will be described.

(b) *The Lymph Capillaries:* When an edema develops in the tissues surrounding the lymph capillaries, a dilatation of the lymph vessels results, although a compression would appear rather to be expected. The explanation lies in the fact that, in contrast to the blood capillaries, the lymph capillaries consist of endothelial cells "to which fibers of the surrounding connective tissue are attached" (Pullinger and Florey). Thus, while a part of the fluid from the blood capillaries forms an edema in the tissue spaces, another part causes the fibers of the connective tissues to swell. "As the connective tissue fibers become edematous and swollen, tension on the fibers attached to the lymph capillaries causes their walls to be drawn apart, their dilatation thus being passive" (Pullinger and Florey).

The dilatation of the lymph vessels effects an increase of their resorptive capacity, this being their essential function. Therefore, an increased resorption of the fluid, toxins, and cell debris accumulated in the area of inflammation is brought about. This, however, is the case only as long as the transudation of the serum from the blood capillaries prevails or, in other words, during the edematous stage of the inflammatory process. Performed in this early stage, irradiation causes an increase of the perivascular edema, which is readily followed by an increased resorption through the lymph capillaries of the fluid containing many toxic products.

The situation changes, however, when

the emigration of the leukocytes is the prevailing feature, as is the case during the suppurative stage of the inflammatory process. In this more advanced stage, irradiation causes an increased migration of white cells, which, however, is not followed by their increased resorption, first, because the leukocytes encounter more difficulties in entering the lymphatics, but mainly because the passage through the lymph vessels is more difficult since their lumen is blocked by the formation of fibrin (Menkin). If an inflammatory process is irradiated in an advanced stage of suppuration, when the passage through the lymphatics is blocked, instead of an increased resorption an accelerated abscess formation takes place in the infected area. Left to itself this will of necessity perforate the surface and free drainage will result. Thus, while in an early stage the effect of irradiation may be likened to that of an injection of serum, in an advanced stage it may have the effect of a surgical incision.

The particular kind of radiation effect which will result cannot be predicted with certainty because often the stage of the inflammation cannot be differentiated clinically and, above all, because both stages often concur. While a number of lymph vessels may be open, others may be closed or be only partially blocked. In the majority of cases, therefore, the final result of irradiation of an inflammatory process consists partly in retrogression, owing to resorption through the lymphatics, and partly in perforation through the skin, owing to abscess formation.

(c) *The Arteries and Veins:* According to the prevailing opinion, all blood vessels are dilated and hyperemic in the state of erythema caused by irradiation. Closer analysis, however, discloses that both roentgen and radium rays produce an enlargement of the capillaries only, but are unable to bring about a dilatation of the arteries and veins. This stems from the fact that the arteries and veins are composed not only of endothelium, as are the capillaries, but also of muscular and fibrous tissue, forming a coat around the endothe-

lial layer. Hence their designation as "strong" vessels in contrast to the capillaries, or "minute" vessels (Lewis).

The muscular and fibrous tissues, being only slightly radiosensitive, give the vessels the strength to resist the rays. The arteries and veins therefore remain unaffected by doses effective in the capillaries. As a consequence, the arteries and veins undergo no dilatation, while the capillaries become dilated and subsequently hyperemic. What is even more important, while the capillaries are enlarged, the arteries and veins appear to be narrowed by the same dose. This is due to the swelling of the endothelial cells which, unable to expand, of necessity protrude into the lumen. If a larger dose is given, in addition to the swelling of the endothelial cells an edema is produced within the walls of the vessels, thus contributing even more to a narrowing of their lumen. With very large doses an inflammation of the walls, an arteritis or phlebitis, results, which ultimately can give rise to a complete occlusion of the vessel. Since the arteries have a smaller lumen than the veins, the narrowing effect of radiation is more pronounced in the former. The narrowing of the arterial lumen is also more important, since occlusion of the arteries may lead to ischemia and necrosis of the tissues supplied by them. It is because dilatation of the capillaries is associated with a narrowing of the arteries and veins that an erythema caused by radiation is more serious than that produced by sunlight and other vasodilative agents.

While a large dose is required to produce a dilatation of the normal capillaries and coincidentally a narrowing of the normal arteries, a small dose is sufficient to produce these phenomena in the stage of inflammation, since, as has already been mentioned, the blood vessels display a greater irritability in an inflammatory condition. Consequently a small dose will produce a further enlargement of the capillaries and at the same time reduce the dilated arteries to their normal lumen.

Because of the selective action of roent-



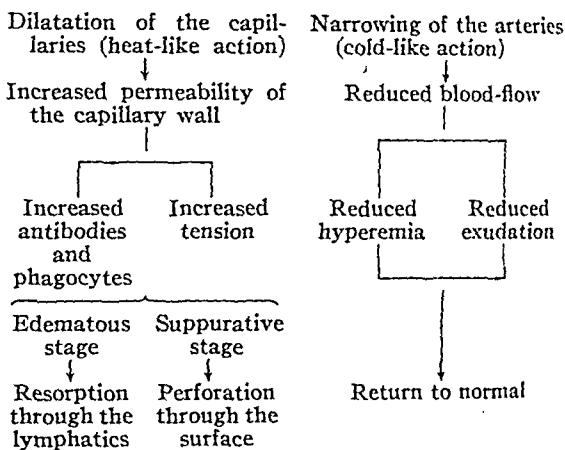
gen and radium rays on the capillaries, arteries, and veins, the effectiveness of irradiation differs greatly from that of heat. While both can produce a dilatation of the capillaries, radiation in a milder degree than heat, heat also dilates the arteries and veins, *via* the nerves and spinal centers, and consequently intensifies the inflammatory process. Irradiation, on the other hand, narrows the arteries and consequently tends to reduce the hyperemia. It is probably for this reason that radiation proves successful in the treatment of inflammatory processes which heat has failed to cure.

The retrogression of the hyperemia and exudation, the two features so characteristic of an inflammatory condition, is one of the most striking effects of radiation therapy. In this respect the effectiveness of rays resembles the action of cold, which likewise causes a narrowing of the arteries, thus producing its antiphlogistic effect. There is, however, an important difference between the two agents. Cold narrows the arteries to the same extent, regardless of whether it is applied to normal or inflamed vessels. A radiation dose which is effective in an inflammatory condition has, however, no effect on normal arteries. Only an artery previously dilated by an inflammatory agent is affected by the dose used in inflammation and only to the extent of restoring the normal lumen.

One thus arrives at the concept that irradiation obviously has the effect of both heat and cold, but in a milder degree. Irradiation, like heat, causes a dilatation of the capillaries but, like cold, it also causes a narrowing of the arteries. Like heat, it accelerates the detoxication and resorption of the inflammatory process or abscess formation; like cold, it lessens the

hyperemia and exudation. By this combination a shortening of the inflammatory process is effected, which can hardly be obtained at present by any other conservative method.

The following outline may serve as a summary of the preceding discussion on the effectiveness of radiation on inflammations.



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#### REFERENCES

- FREUND, L.: *Elements of General Radiotherapy*. Eng. trans., New York, Rebman Co., 1904.  
 HEIDENHAIN, L., AND FRIED, C.: *Arch. f. klin. Chir.* 133: 624-665, 1924.  
 PORDES, F.: *Fortschr. a. d. Geb. d. Röntgenstrahlen* 31: 287-297, 1923-24.  
 HOLZKNECHT, G.: *Am. J. Roentgenol.* 15: 332-336, 1926.  
 MUSKATBLIT, E., AND OUSPENSKY, B.: *Arch. Dermat. & Syph.* 27: 953-955, 1933.  
 FUKASE, S.: *Virchows Arch. f. path. Anat.* 273: 794-805, 1929.  
 MOTOJIMA, T.: *Strahlentherapie* 29: 30-70, 1928.  
 DESJARDINS, A. U.: *J. A. M. A.* 116: 225-231, 1941.  
 BENJAMIN, E., VON REUSS, ET AL.: *Wien. klin. Wchnschr.* 19: 788-794 1906.  
 PULLINGER, B. D., AND FLOREY, H. W.: *Brit. J. Exper. Path.* 16: 46-61, 1935; *J. Path. & Bact.* 45: 157-170, 1937.  
 MENKIN, VALY: *Dynamics of Inflammation*. New York, Macmillan Co., 1940.  
 LEWIS, THOMAS: *The Blood Vessels of the Human Skin and Their Responses*. London, Shaw & Sons, 1927.  
 BORAK, J.: *Radiology* 38: 481-492, 607-617, 718-727, 1942.

# Roentgen Therapy with Low Dosage in Suppurative Infections<sup>1</sup>

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ABOUT TWENTY-TWO years ago I was given x-ray treatment for a threatened otitis media. That was my introduction to a form of therapy the use of which was then just beginning. Since that time tens of thousands of infections of various kinds have been given x-ray treatment, with benefit in most cases.

The usual dose has been in the neighborhood of that given in Friedman's *Manual of Radiotherapy* (1), namely, 100 r. While in most cases this dosage is effective, we have noticed that an occasional infection tends to remain latent, without much supuration, and that the inflammation fails to recede promptly. In view of the fact, long known, that the action of the x-ray beam is principally on the white blood cells that infiltrate the infected area, it occurred to me that over-treatment might possibly be responsible for delayed healing. About two years ago, therefore, I began to reduce my dosage, first to 80 r, later to 65 r, and in turn to 50, 35, and finally 25 r.

Increasingly better results were observed as the dosage reached 50 r and below. For the past year I have used 25 r in most cases, rarely increasing to 35 or 50 r in the presence of comparatively limited inflammation or deep penetration. The best response is usually obtained in the worst cases, with severe inflammatory changes. The rays are generated at 100 to 120 kv., with no filtration in very superficial infections and 1.0 or 2.0 mm. aluminum for those deeper or more indurated. In unresolved pneumonia we employ 150 kv., 0.5 mm. copper and 1.0 mm. aluminum. Usually treatments are given on successive days until there is either free drainage or the inflammation and induration have subsided or the lesion is ready for incision.

In the series reported here (Table I)

<sup>1</sup> Accepted for publication in September 1943.

it will be noted that the lesions in more than half were either draining or ready for incision after the third day. Out of the entire series in which treatment could be carried to the point where it was felt that no further therapy was needed, only one unsatisfactory result was recorded. This patient had grossly swollen cervical nodes following tonsillitis. She showed no apparent benefit after three treatments with 25 r and the dosage was then increased to 75 r, still with no response. About a month later, we understand, a deep abscess was found in the cervical region. This case is not included in the table because of the varied dosage. With my present knowledge, I would continue treatment at 25 r in such a case with the expectation that if a necrotic focus were present it would become localized successfully.

In no case was any change in medical or local treatment asked. Many patients received sulfa drugs, with which there was no conflict at this dosage, and none showed any skin change as a result of treatment in the presence of these drugs. At higher dosage this might be expected in some instances. The superb co-operation of my colleagues aided greatly in carrying the treatments to a conclusion.

It will be noted that only one contaminated traumatic wound is listed in this series. We believe, with James Kelly of Omaha (2), that all such cases could be more safely handled, with more prompt healing, if a short course of x-ray therapy were given. This would interfere in no way with either medical or surgical measures. Sloughing of the tendons and spread of infection beyond the surgical field could be avoided in most cases.

Our total man power in this country, both civil and military, may be placed at thirty million, at least. If we assume an

TABLE I: ROENTGEN THERAPY IN SUPPURATIVE INFECTIONS

Diagnosis	Number of Cases	Duration	Average Number of Treatments	Surgery after Treatment	Sulfa Compounds	Results
Erysipeloid infection of face	1	.....	1	No	No	Prompt recovery
Abscessed jaw; dental infection	10	Indefinite, 3 days-3 wk.	4	2.	3	Uneventful recovery
Infected cervical lymph nodes	6	5 days	5	3	3	Uneventful recovery
Acute sinusitis	1	?	3	No	No	Discharged symptomatically relieved
Mastoiditis	2	10 days	3	No	1	Complete recovery
Acute otitis media	2	?	3	No	1	Uneventful recovery
Cellulitis	5	5 days	4	1 incised; 1 aspirated	3	Uneventful recovery
Carbuncles	6	5 days	4	No	No	Uneventful recovery
Boils	3	3 days	3	No	No	Uneventful recovery
Abscess						
Axillary	6	4 wk.	4	1	3	Complete recovery
Breast	1	5 days	4	Yes	No	Recovery uneventful
Coccyx	1	7 days	2	No	No	Recovery uneventful
Palmar	1	6 wk.	4	Previous	No	Recovery uneventful
Postoperative facial	1	4 days	3		No	Recovery prompt
Peritonsillar	1	4 days	4	Previous	No	Recovery uneventful
Infected traumatic wound	1	.....	3	No	No	Infection localized, with recovery
Furunculosis of ear canal	4	?	3.	No	No	Recovery uneventful
Postoperative appendectomy wound	1	1 mo.	4	No	No	Recovery uneventful
Styes	2	4 mo.	4	No	No	Recovery uneventful
Infected corn	1	6 wk.	2	No	No	Recovery uneventful
Unresolved pneumonia	3	4 wk.	4	.....	Before; not after	Prompt symptomatic recovery; resolution slow

annual incidence of suppurative infection of 2 per cent, we have a total of six hundred thousand cases. If, in each of these, three days of illness could be deducted by adding x-ray therapy to other forms of treatment, this would represent a saving of over one million and a half man days for productive effort. This assumption does not seem unreasonable in view of the results obtained in this series. At the same time much suffering could be avoided.

We have treated axillary abscesses, abscesses of the jaw and neck, mastoiditis, carbuncles, cellulitis, erysipeloid infection, otitis media, infected traumatic wounds, infected operative wounds, abscess of the breast, styes, furunculosis of the ear canal, peritonsillar abscess, acute sinusitis, and unresolved pneumonia. While in the series reported single doses were limited to 25 r, it is not contended that this is the optimum dosage in every case. It is be-

lieved, however, that the best results will be obtained if 50 r per dose is not exceeded. In 90 per cent of cases, or more, 25 r is sufficient.

Recently Albert Oppenheimer (3) reported a series of treatments of virus pneumonia at reduced dosage with excellent results. This is in agreement with the above data. Essentially, from the roentgenologic point of view, pneumonia is an infected field highly infiltrated with leukocytes and greatly congested. Treatment should logically be the same as for other infections, with allowance only for depth.

I wish especially to call attention to the limited surgery necessary in carbuncles and abscesses. Nearly 85 per cent drained spontaneously, requiring no incision. As previously noted, our opportunity to treat traumatic lacerated wounds, including compound fractures, has been limited. In

this field we feel that x-ray treatment is of great value and should be used in practically every case.

Whether the small dosage employed would prevent gas bacillus infection we do not know. Neither do we know whether it would cure such an infection once it was established. It might be worthy of trial. Special attention is called to 2 cases:

The patient with peritonsillar abscess had, also, a wired fractured jaw. Incision was attempted unsuccessfully before wiring. The patient was warned that rupture of the abscess would probably fill the throat with pus. This did occur but the pus was expelled without difficulty.

One of the cases of cellulitis, due to an

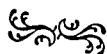
infected blister of the heel, had a very virulent appearance. Such cases have been known to be followed by septicemia with early death. Our patient recovered in three days.

Two of the patients with carbuncles were diabetic. Response to treatment was as good as in non-diabetic cases.

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#### REFERENCES

1. FRIEDMAN, MURRAY M.: A Manual of Radiotherapy. Ann Arbor, Michigan, Edwards Bros., 1942.
2. KELLY, JAMES F., AND DOWELL, D. ARNOLD: Twelve-Year Review of X-Ray Therapy of Gas Gangrene. *Radiology* 37: 421-438, October 1941.
3. OPPENHEIMER, ALBERT: Roentgen Therapy of "Virus" Pneumonia. *Am. J. Roentgenol.* 49: 635-638, May 1943.



# Depth Dose Measurements for 100-, 120-, and 135-kv. Roentgen Rays<sup>1</sup>

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THE PRESENT trend toward larger x-ray doses in the treatment of superficial cancer makes the determination of the amount of radiation delivered to the underlying healthy tissue of greater importance. Such calculations, however, have been limited by the lack of complete depth dose tables for low and intermediate voltages, although numerous data are available for special technics or conditions (1, 5, 7, 10, 12). The present paper is a report on our phantom measurements for half-value layers from 1.0 to 8.0 mm. Al (0.04 to 0.44 mm. Cu).

## EQUIPMENT AND MEASURING INSTRUMENTS

The apparatus was chosen with the aim of duplicating the conditions used clinically and consisted of a shockproof, oil-cooled x-ray tube energized by a half-wave, two-valve 140-kv. generator. The x-ray tube was mounted in a "rayproof" housing, and the total inherent filtration of the pyrex tube wall, oil, and bakelite window was equivalent to approximately 0.5 mm. aluminum. Comparative measurements were carried out, also, with an air-cooled shockproof tube having an inherent filtration of approximately 1 mm. aluminum.

The tube peak kilovoltage was determined by means of a 12.5-cm. sphere gap which had previously been checked at constant potential against a Taylor high-voltage resistance unit. The milliamperage was maintained at a constant value by means of a stabilizer of the saturated core type. The radiation was measured with two bakelite thimble chambers coated on the inside with aquadag and having

inside diameters of 0.52 cm. and 0.72 cm. respectively, with volumes of 0.40 c.c. and 1.27 c.c. Measurements at the surface and down to 5 cm. depth were made with both chambers, while at depths below 5 cm. the larger chamber only was used. A well shielded electrometer of the Wulf type was permanently connected to the chamber used.

## CHOICE OF PHANTOM MATERIAL

Preliminary experiments were made to determine the best phantom material for the ray qualities used. Water, being the main constituent of human tissue, has been preferred by several earlier investigators. It has, however, practical disadvantages. It is an electric conductor, which prevents its use with ionization chambers of the Failla extrapolation type (4) and, furthermore, since it is a liquid, it is difficult to obtain layers of definite thickness or cross section. Of the many

TABLE I: COMPARISON OF WATER AND MASONITE PHANTOMS

(100 kv.p. Filter = 1.0 mm. Al. H.V.L. = 2.0 mm. Al. T.S.D.  $\approx$  30 cm. Diameter of field = 15 cm.)

	Water	Masonite
Half immersed	100%	100%
5 cm. depth	32.2%	38.0%
10 cm. depth	10.4%	14.6%

solid substances used as phantom material, "masonite presdwood" has been the most satisfactory. "Masonite presdwood" is a wood fiber board manufactured by exploding wood chips by high pressure steam. Presdwood phantom measurements were first made by Quimby and collaborators (9), who found that masonite of unit density gave the same depth dose as water for 200-kv. radiation. In a previous paper (3) we reported that higher depth doses were obtained with masonite

<sup>1</sup> From the Physics Laboratory, Department of Hospitals, City of New York. Presented before the New York Roentgen Society, New York Academy of Medicine, May 17, 1943. Accepted for publication in August 1943.

TABLE II: COMPARISON OF ABSORPTION IN WATER AND MASONITE\*

H.V.L. (mm.)	0.6 Al	2.0 Al	8.0 Al	0.9 Cu	1.8 Cu
Kv.p.	60	100	135	200	200
Filter (mm.)	0	1.0Al	0.25 Cu + 1.0 Al	0.50 Cu + 1.0 Al	2.0 Cu + 1.0 Al
4.85 cm.					
Water	6.7%	19.5%	38.2%	42.6%	46.1%
Masonite	10.3%	23.8%	42.5%	44.0%	46.7%
9.70 cm.					
Water	...	5.8%	15.0%	17.8%	20.7%
Masonite	...	7.5%	18.0%	20.0%	22.1%

\*Figures indicate per cent transmitted using the arrangement shown in Figure 1, and masonite of density 0.985.

than with water when 40- to 50-kv. radiation was used, as applied in "contact" therapy. The absolute difference, however, was small, about 3 per cent at 1.0 cm. depth, as the short target skin distance, 2.0 cm., caused a low depth dose for either material in accordance with the inverse square law. Measurements made in the present investigation showed marked differences in depth dose between the two types of phantom material, as indicated in Table I. The density of the masonite was 0.985 gm. per c.c., and the dimensions of the two phantoms were identical: 30 X 30 cm. and 25 cm. high. Special tests made with the chamber enclosed in lead indicated that the ionization measured was that of the chamber only.

Comparative measurements were made, also, with different types of masonite as used in other laboratories.<sup>2</sup> The results of these tests showed similar differences when the density was approximately unity, which, however, was not always the case. In order to determine which of the two phantom materials, water or masonite, simulates human tissue more closely, we made a series of tests using the arrangement shown in Figure 1. After several preliminary runs, eliminating experimental difficulties, the absorption of the biceps was measured in 11 patients, in each instance for two ray qualities. This work was carried out with the co-operation of Dr. George C. Andrews of the Department of Dermatology, Columbia University, and Dr. Samuel Richman of Morrisania City Hospital. The biceps was chosen as the

part of the body of suitable thickness which could be irradiated with the least inconvenience to the patient. A telescopic cone, 4 cm. in diameter, was used, with the weight of the lower part, 624.2 gm., resting on the patient's arm, giving constant compression. The thickness of the arm was determined by measuring the extension of the cone. Special care was taken to exclude the humerus from the beam in order to avoid the greater absorption by the bone. This was checked by means of radiographs taken simultaneously with the ionization measurements.

Next, various layers of water and masonite were substituted for tissue. The results of these tests are shown in Figure 2, where the solid lines indicate the water and the dotted lines the masonite absorption curves. The two ray qualities selected were the practical upper and lower limits of the equipment used. The circles represent the measurements of the patients. It will be noted that the absorption of tissue corresponds much more closely to that of water. Due to the contour of the biceps, it was not possible in every case to have the whole bottom of the cone in contact with the skin, and the small air space at the edge may account for the slightly higher values of some of the circles.

Similar comparisons were made between water and masonite for other ray qualities, and the results are shown in Table II. As indicated, the difference becomes insignificant as the half-value layer is increased. This may be explained by the carbon content of the masonite. At the longer wave lengths, or lower half-value layers, where the photoelectric absorption

<sup>2</sup> Some of these were obtained through the courtesy of L. Marinelli of Memorial Hospital and Miss Lilian Jacobson of Montifiore Hospital.

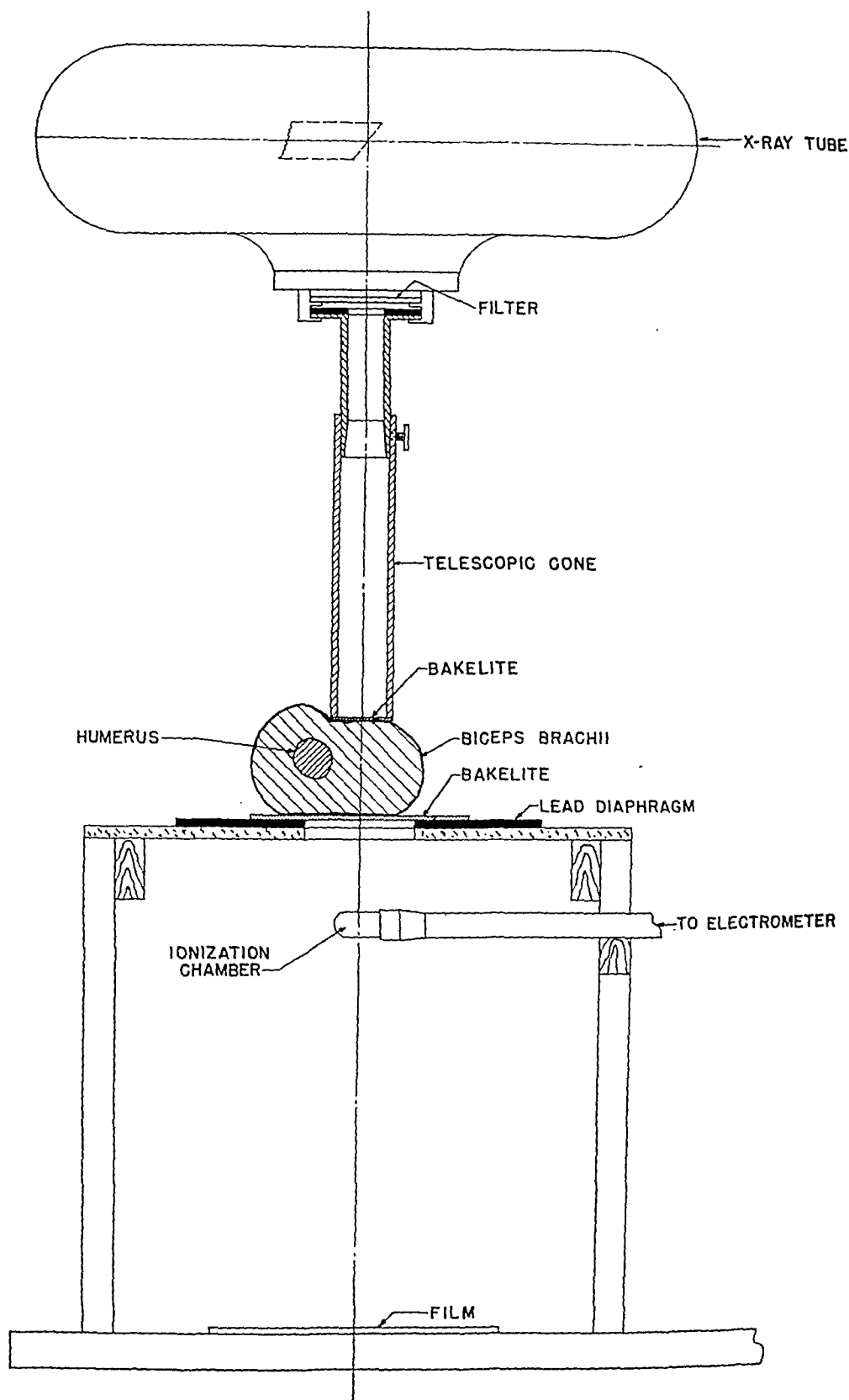


Fig. 1. Schematic diagram of arrangement used in comparing the absorption of "masonite presdwood" and water with tissue.

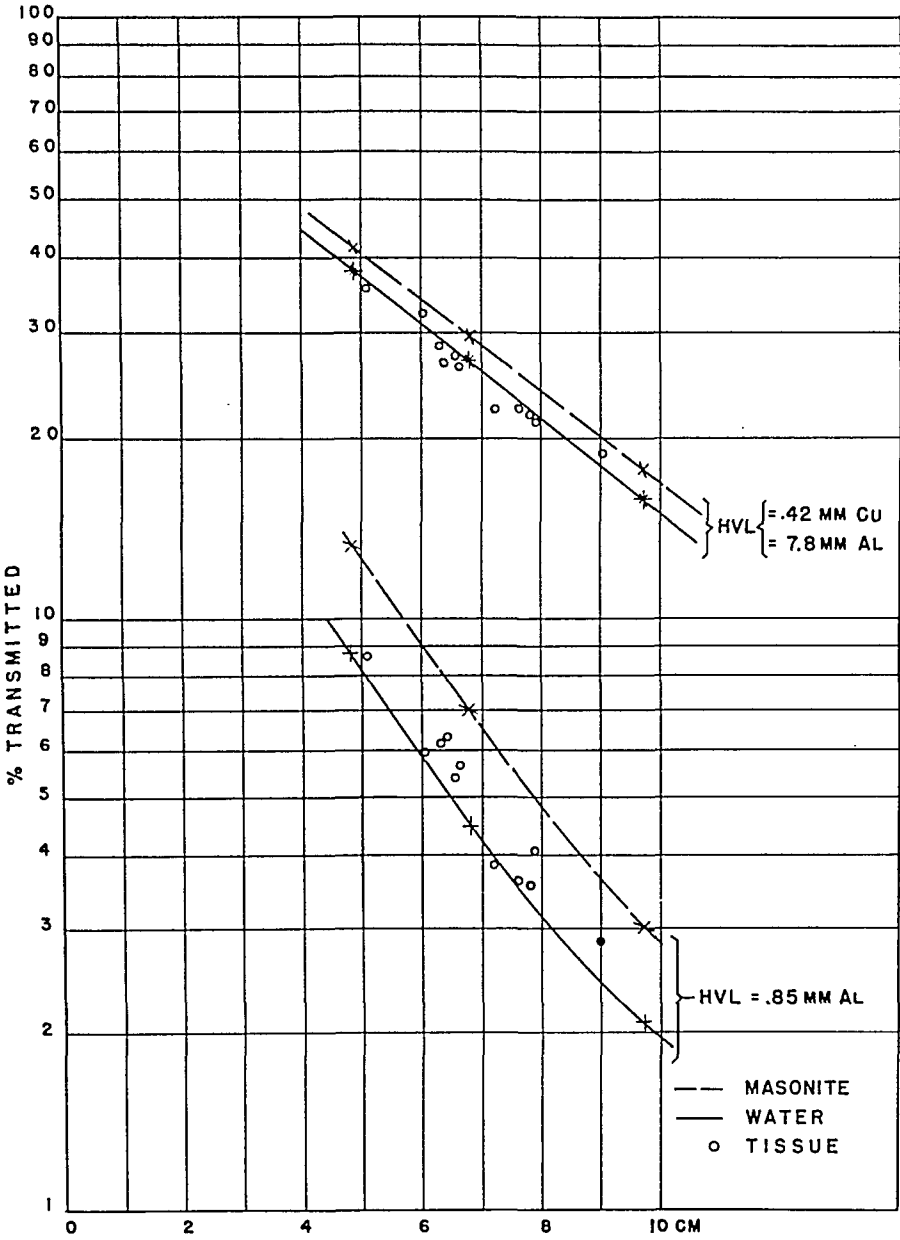


Fig. 2. Results of absorption measurements in "masonite presdwood," water, and tissue.

is predominating, the absorption of masonite is less, due to its carbon. At shorter wave lengths, where the absorption is caused mainly by Compton scattering, the difference becomes insignificant.

In view of these findings, we concluded that water is the more accurate phantom material for depth dose measurements for half-value layers less than 0.9 mm. Cu. At the conclusion of these experiments there appeared an article by F. W. Spiers (11)

of Leeds, England, who arrived at similar findings, based upon an extensive study of different types of phantom materials.

WATER PHANTOM MEASUREMENTS

Our water phantom arrangement is shown in Figure 3. The ionization chamber stem passes through a watertight bushing in the side of the tank which is 30 X 30 cm. and 26 cm. high. Surface measurements were made with the chamber



TABLE III: EFFECT OF DISTANCE ON DEPTH DOSE

Kv.	Cu	Al	H.V.L. (mm. Al)	T.S.D. (cm.)	Diameter of Field (cm.)	Depth Dose at 5 Cm. Measured	Depth Calculated
100	...	0	1.0	15	2.7	8.3%	8.2%
				30	2.7	10.7%	
135	0.25	1.0	8.0	15	2.7	25.6%	25.7%
				30	2.7	33.5%	
100	...	0	1.0	15	5.0	10.7%	11.2%
				30	5.0	14.7%	
135	0.25	1.0	8.0	15	5.0	33.2%	31.3%
				30	5.0	40.8%	

TABLE IV: DEPTH DOSE FOR H.V.L. 1.0 MM. AL  
(In roentgens per 100 r at skin)

Area in sq. cm. → Diam. in cm. →	1 (1.1)	5 (2.5)	10 (3.6)	25 (5.6)	50 (8)	75 (9.8)	100 (11.3)	200 (16)	300 (20)	400 (22.6)
T.S.D. = 15 cm.										
"Air" Dose →	98	96	92	89	88	88	87	87		
Skin Dose →	100	100	100	100	100	100	100	100		
0.5 cm.	63	64	67	73	73	74	75	77		
1	46	48	51	57	58	59	60	62		
2	27	29	32	37	39	40	41	43		
3	17	19	21	25	27	28	29	30		
4	11	13	14	17	19	20	21	22		
5	7	9	10	12	13	14	15	15		
6	5	6	7	8	9	10	11	11		
7	4	4	5	5	7	8	8	9		
8	2	3	3	4	5	6	6	7		
9	2	2	2	3	4	4	4	5		
10	1	1	2	2	3	3	3	4		
T.S.D. = 20 cm.										
"Air" Dose →	98	96	92	89	88	88	87	87	86	
Skin Dose →	100	100	100	100	100	100	100	100	100	
0.5 cm.	64	65	68	74	74	75	76	78	79	
1	48	49	52	59	60	62	63	64	65	
2	28	31	34	39	42	43	44	45	46	
3	18	21	23	27	30	31	32	33	34	
4	12	14	16	19	21	22	23	24	25	
5	8	10	11	13	15	16	16	17	18	
6	6	7	8	10	11	12	12	13	14	
7	4	5	6	7	8	9	9	11	11	
8	3	4	4	5	6	7	7	8	9	
9	2	2	3	4	4	5	5	6	7	
10	1	2	2	3	3	4	4	5	5	
T.S.D. = 30 cm.										
"Air Dose →	98	96	92	89	88	88	87	87	86	86
Skin Dose →	100	100	100	100	100	100	100	100	100	100
0.5 cm.	65	66	69	75	76	77	78	79	81	83
1	49	51	54	60	62	63	65	66	67	69
2	30	33	36	41	44	46	46	48	49	50
3	20	23	25	29	32	34	34	36	37	38
4	14	16	18	21	24	25	26	27	28	28
5	10	11	13	15	17	18	19	20	21	21
6	7	8	9	11	13	14	14	15	16	17
7	5	6	7	8	10	11	11	13	14	14
8	3	4	5	6	7	8	9	10	11	11
9	2	3	4	4	5	6	7	8	8	9
10	1	2	3	3	4	5	5	6	6	7

in the upper position, half-immersed. As the water level was raised, the x-ray tube was brought up correspondingly by means of automatic stops to maintain a constant target surface distance of either 30 or 15 cm. These distances were chosen as the most practical for low-voltage radiation with *present* shockproof equipment. The

15 cm. target-skin distance is the shortest which will permit accurate positioning for small fields. A minimum of 30 cm. distance is required to secure fairly uniform surface distribution with larger areas. Due to the inverse square law, the peripheral intensity of a 15-cm. field is only 80 per cent of that at the center with a target-skin distance of 15 cm., but 94 per cent

tical, while with the larger area the difference is of some significance. Various investigators report different values for this relationship. Mayneord and Lamer-ton (6) obtained a larger measured depth dose than the calculated value when reducing the target-skin distance, while Quimby (8) found no difference between the calculated and measured depth dose.

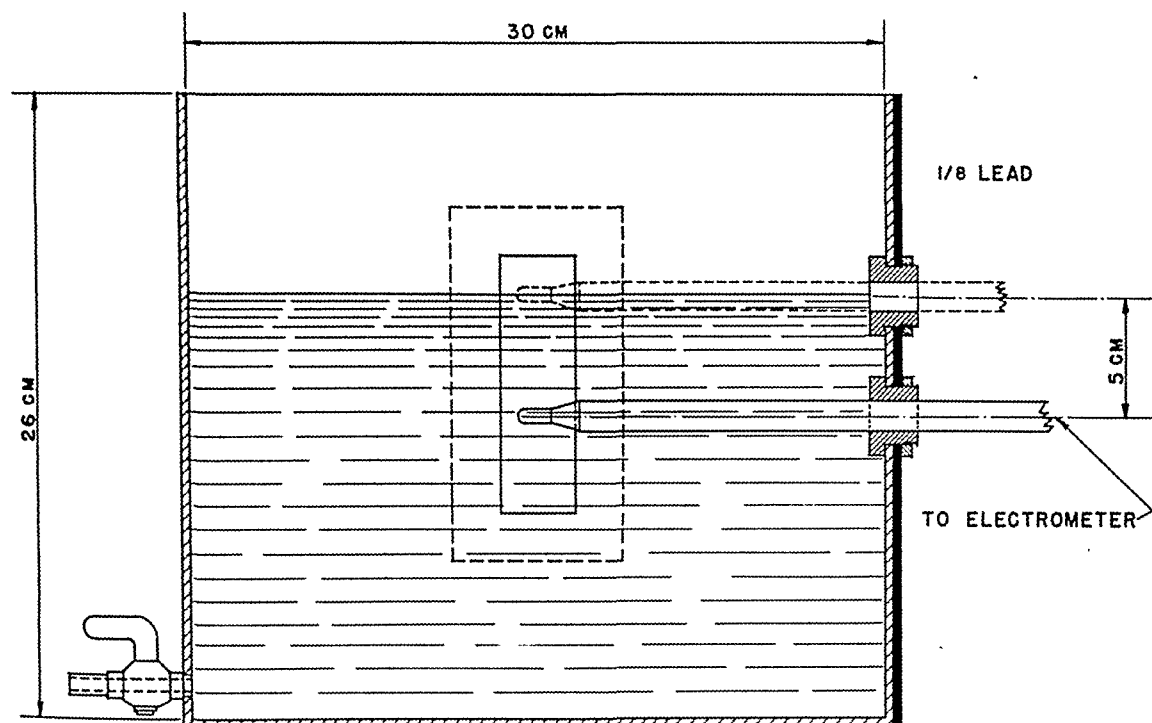


Fig. 3. Schematic diagram of water phantom.

when the target-skin distance is increased to 30 cm. There is a further reduction in the peripheral dose due to the non-uniform radiation distribution of the x-ray tube. This reduction depends upon the construction of the tube and its housing, but becomes also less as the target-skin distance is increased, as shown by Atlee and Trout (2).

#### RESULTS

In Table III is shown a comparison of the depth dose for 15 cm. T.S.D. obtained by direct measurements, and by calculation, applying the inverse square law to the 30 cm. depth dose data. With the small field the results are practically iden-

In view of the many factors affecting this ratio, this apparent discrepancy is not surprising. The size of the focal spot, off-focus radiation, and the collimating system all influence the relationship. As these factors differ with the type of equipment used, all our data are based on the measurements made with 30 cm. target-skin distance where greater accuracy was possible.

The results of the water phantom depth dose measurements are given for the various half-value layers in Tables IV to XI. The voltage and filtration used to obtain these half-value layers are shown in Table XII. However, it is necessary only to use the same half-value layers to get the indicated depth doses. Any error

TABLE V. DEPTH DOSE FOR H.V.L. 2.0 MM. AL  
(In roentgens per 100 r at skin)

Area in sq. cm. → Diam. in cm. →	1 (1.1)	5 (2.5)	10 (3.6)	25 (5.6)	50 (8)	75 (9.8)	100 (11.3)	200 (16)	300 (20)	400 (22.6)
T.S.D. = 15 cm.										
"Air" Dose →	97	92	89	85	83	83	83	81		
Skin Dose →	100	100	100	100	100	100	100	100		
0.5 cm.	72	76	78	82	83	84	84	85		
1	55	58	63	69	70	71	72	73		
2	34	39	43	49	51	52	53	55		
3	22	27	30	35	38	39	40	42		
4	15	20	22	25	28	30	31	32		
5	10	14	16	18	21	22	23	25		
6	7	10	11	13	15	17	18	19		
7	5	7	8	10	11	12	13	15		
8	4	5	6	7	8	9	10	11		
9	3	4	4	5	6	7	7	8		
10	2	3	3	4	5	5	6	6		
T.S.D. = 20 cm.										
"Air" Dose →	97	92	89	85	83	83	83	81	81	
Skin Dose →	100	100	100	100	100	100	100	100	100	
0.5 cm.	73	77	79	83	84	84	85	86	88	
1	56	60	65	71	73	74	75	76	78	
2	36	42	46	52	54	56	56	58	59	
3	24	30	33	38	41	43	44	46	47	
4	17	22	24	28	31	33	34	36	36	
5	12	16	18	21	24	25	26	28	29	
6	8	12	13	15	18	19	20	22	23	
7	6	8	9	11	13	15	15	17	18	
8	4	6	7	8	10	11	12	13	14	
9	3	4	5	6	8	8	9	10	11	
10	2	3	4	5	6	6	7	8	8	
T.S.D. = 30 cm.										
"Air" Dose →	97	92	89	85	83	83	83	81	81	81
Skin Dose →	100	100	100	100	100	100	100	100	100	100
0.5 cm.	74	79	81	85	86	86	87	88	90	90
1	58	62	67	73	75	76	77	78	80	81
2	39	44	48	55	58	59	60	62	63	64
3	26	33	36	42	45	47	48	50	51	51
4	19	25	27	32	35	37	38	40	41	41
5	14	18	21	24	27	29	30	33	33	33
6	10	14	16	18	21	23	24	26	26	27
7	7	10	11	14	16	17	18	21	22	22
8	5	7	8	10	12	13	14	16	17	18
9	4	6	6	8	9	10	11	12	13	14
10	3	4	5	6	7	8	9	10	11	12

TABLE VI: DEPTH DOSE FOR H.V.L. 4.0 MM. AL  
(In roentgens per 100 r at skin)

Area in sq. cm. → Diam. in cm. →	1 (1.1)	5 (2.5)	10 (3.6)	25 (5.6)	50 (8)	75 (9.8)	100 (11.3)	200 (16)	300 (20)	400 (22.6)
T.S.D. = 15 cm.										
"Air" Dose →	97	90	88	83	81	79	78	75		
Skin Dose →	100	100	100	100	100	100	100	100		
0.5 cm.	81	84	85	89	90	91	92	92		
1	66	70	71	78	80	82	83	84		
2	46	49	52	61	63	64	65	68		
3	33	35	39	46	50	51	52	53		
4	23	25	28	35	38	40	41	42		
5	16	18	21	26	30	31	32	33		
6	12	13	15	19	21	23	24	26		
7	8	10	11	14	16	17	18	20		
8	6	8	9	11	12	13	14	16		
9	4	6	6	8	10	10	11	13		
10	3	4	5	6	7	8	9	10		
T.S.D. = 20 cm.										
"Air" Dose →	97	90	88	83	81	79	78	75	75	
Skin Dose →	100	100	100	100	100	100	100	100	100	
0.5 cm.	82	84	86	90	91	92	93	93	95	
1	68	73	74	81	83	85	85	87	88	
2	48	52	56	64	67	68	69	72	73	
3	35	39	42	50	54	55	57	58	60	
4	26	28	31	39	43	44	46	47	48	
5	19	21	24	30	34	35	36	38	39	
6	14	15	18	22	25	27	28	30	31	
7	10	12	13	17	19	21	22	24	25	
8	7	9	10	13	15	16	17	19	21	
9	5	7	8	10	12	13	14	16	17	
10	4	5	6	8	9	10	11	12	13	
T.S.D. = 30 cm.										
"Air" Dose →	97	90	88	83	81	79	78	75	75	74
Skin Dose →	100	100	100	100	100	100	100	100	100	100
0.5 cm.	84	86	88	92	93	94	95	95	97	97
1	71	75	76	84	85	87	88	90	91	92
2	52	55	59	68	71	73	74	76	78	80
3	39	42	46	55	59	60	62	63	65	66
4	29	31	35	44	48	49	51	52	54	55
5	21	24	27	34	39	41	42	43	45	46
6	16	18	21	26	29	32	33	35	37	38
7	12	14	16	20	23	25	26	29	30	32
8	9	11	12	16	18	20	21	23	25	27
9	7	9	10	12	14	16	17	19	21	22
10	5	7	8	10	12	13	14	16	17	18

TABLE VII: DEPTH DOSE FOR H.V.L. 8.0 MM. AL (0.44 MM. CU)  
(In roentgens per 100 r at skin)

Area in sq. cm. → Diam. in cm. →	1 (1.1)	5 (2.5)	10 (3.6)	25 (5.6)	50 (8)	75 (9.8)	100 (11.3)	200 (16)	300 (20)	400 (22.6)
T.S.D. = 15 cm.										
"Air" Dose →	96	90	87	83	78	76	75	72		
Skin Dose →	100	100	100	100	100	100	100	100		
0.5 cm.	83	84	87	91	92	92	93	95		
1	70	71	76	83	85	86	87	89		
2	51	55	59	68	71	73	74	77		
3	38	43	47	54	58	61	62	65		
4	28	34	36	42	47	50	52	54		
5	21	26	28	33	37	40	42	44		
6	16	19	21	25	29	32	33	36		
7	12	15	16	19	23	25	27	29		
8	9	11	13	15	18	20	21	24		
9	7	9	10	12	15	16	17	20		
10	5	7	7	9	11	13	14	16		
T.S.D. = 20 cm.										
"Air" Dose →	96	90	87	83	78	76	75	72	71	
Skin Dose →	100	100	100	100	100	100	100	100	100	
0.5 cm.	84	85	88	92	93	93	95	96	96	
1	73	74	79	85	88	89	90	92	93	
2	55	59	63	72	76	78	79	81	83	
3	41	47	51	59	64	67	68	71	72	
4	31	38	40	47	53	56	58	60	61	
5	24	29	32	37	42	46	47	50	51	
6	18	23	25	29	34	37	39	42	43	
7	14	18	19	23	27	30	31	34	36	
8	11	14	15	18	22	24	25	29	31	
9	8	11	12	14	18	19	21	24	26	
10	6	8	9	12	14	15	17	20	21	
T.S.D. = 30 cm.										
"Air" Dose →	96	90	87	83	78	76	75	72	71	70
Skin Dose →	100	100	100	100	100	100	100	100	100	100
0.5 cm.	86	87	90	94	95	95	97	98	98	99
1	75	76	81	88	91	92	93	95	96	97
2	58	63	67	76	80	82	84	87	88	90
3	45	51	55	64	69	73	74	77	78	79
4	35	42	45	53	59	62	64	67	68	69
5	27	33	37	43	49	52	54	57	59	60
6	21	26	29	34	40	43	45	49	51	52
7	17	21	23	27	32	35	38	41	43	45
8	13	17	18	22	26	29	31	35	37	38
9	10	13	15	18	22	24	26	30	33	34
10	8	10	12	15	18	20	21	25	27	29
T.S.D. = 40 cm.										
"Air" Dose →	96	90	87	83	78	76	75	72	71	70
Skin Dose →	100	100	100	100	100	100	100	100	100	100
0.5 cm.	87	87	91	95	96	96	97	99	99	99
1	77	78	83	90	92	94	94	97	98	99
2	60	64	69	79	83	85	86	89	91	93
3	47	54	58	67	73	76	78	81	82	83
4	37	45	48	56	63	66	69	72	73	74
5	29	36	40	46	52	57	59	62	63	64
6	23	29	32	38	43	47	49	53	55	57
7	18	23	26	30	35	39	41	46	48	50
8	15	18	21	25	30	32	35	39	42	43
9	11	15	17	20	25	27	29	33	37	38
10	9	12	13	17	20	22	24	28	31	33

## DEPTH DOSE MEASUREMENTS

TABLE VIII: DEPTH DOSE FOR H.V.L. 1.0 MM. AL  
(In roentgens per 100 r "in air")

Area in sq. cm. → Diam. in cm. →	1 (1.1)	5 (2.5)	10 (3.6)	25 (5.6)	50 (8)	75 (9.8)	100 (11.3)	200 (16)	300 (20)	400 (22.6)
T.S.D. = 15 cm.										
"Air" Dose → Skin Dose → 0.5 cm.	100	100	100	100	100	100	100	100	100	100
1	102	106	109	112	114	114	115	115	115	115
2	64	68	73	81	84	85	86	86	88	88
3	47	51	55	63	66	68	69	71	71	71
4	27	31	35	41	45	46	47	49	49	49
5	17	20	23	28	31	32	33	35	35	35
6	11	14	16	19	22	23	24	25	25	25
7	7	9	11	13	15	16	17	17	17	17
8	5	7	7	9	11	12	12	13	13	13
9	4	5	5	6	8	9	9	11	11	11
10	2	3	3	4	6	7	7	8	8	8
	2	3	3	4	5	6	6	7	7	7
	1	2	2	3	4	5	5	6	6	6
	1	1	2	2	3	4	4	4	4	4
T.S.D. = 20 cm.										
"Air" Dose → Skin Dose → 0.5 cm.	100	100	100	100	100	100	100	100	100	100
1	102	106	109	112	114	114	115	115	116	116
2	65	69	74	82	85	86	87	89	92	92
3	49	52	57	66	69	70	72	74	76	76
4	29	33	37	43	47	49	50	52	54	54
5	19	22	25	30	34	35	36	38	39	39
6	12	15	17	21	24	25	26	28	29	29
7	9	10	12	15	17	18	19	20	21	21
8	6	8	9	11	13	13	14	15	16	16
9	4	5	6	8	9	10	11	12	13	13
10	3	4	4	6	7	8	8	9	10	10
	3	4	4	5	6	6	7	7	8	8
	2	3	3	4	5	6	6	7	7	7
	1	2	2	3	4	4	5	5	6	6
T.S.D. = 30 cm.										
"Air" Dose → Skin Dose → 0.5 cm.	100	100	100	100	100	100	100	100	100	100
1	102	106	109	112	114	114	115	115	116	116
2	66	70	75	84	86	88	89	91	93	96
3	50	54	59	68	71	72	74	76	78	80
4	31	35	39	46	50	52	53	55	57	58
5	20	24	27	33	37	38	40	41	42	44
6	14	17	19	24	27	28	29	31	32	33
7	10	12	14	17	20	21	22	23	24	25
8	7	9	10	13	15	16	16	18	19	19
9	5	7	7	9	11	12	13	15	16	16
10	4	5	5	7	8	9	10	12	12	13
	4	5	5	6	7	8	8	9	10	10
	2	3	3	4	5	6	6	7	7	8
	1	2	2	3	4	5	5	6	6	7

TABLE IX: DEPTH DOSE FOR H.V.L. 2.0 MM. AL  
(In roentgens per 100 r "in air")

Area in sq. cm. → Diam. in cm. →	1 (1.1)	5 (2.5)	10 (3.6)	25 (5.6)	50 (8)	75 (9.8)	100 (11.3)	200 (16)	300 (20)	400 (22.6)
T.S.D. = 15 cm.										
"Air" Dose →	100	100	100	100	100	100	100	100		
Skin Dose →	103	109	112	117	120	121	121	123		
0.5 cm.	74	83	88	96	99	101	102	105		
1	56	63	70	80	84	86	87	90		
2	35	43	48	57	61	63	64	67		
3	23	30	34	41	45	48	49	52		
4	16	22	24	30	34	36	37	40		
5	11	16	18	21	25	27	28	31		
6	7	11	13	15	19	20	21	24		
7	5	8	9	11	14	15	16	18		
8	4	6	7	8	10	11	12	14		
9	3	4	5	6	7	8	9	10		
10	2	3	3	4	6	6	7	8		
T.S.D. = 20 cm.										
"Air" Dose →	100	100	100	100	100	100	100	100	100	
Skin Dose →	103	109	112	117	120	121	121	123	123	
0.5 cm.	75	84	89	97	101	102	103	106	108	
1	58	66	73	83	87	89	90	93	95	
2	37	45	51	61	65	67	68	72	73	
3	25	33	37	45	49	52	53	56	57	
4	17	24	27	33	38	40	41	44	45	
5	12	18	20	24	28	31	32	35	35	
6	9	13	15	18	21	23	25	27	28	
7	6	9	10	13	16	18	19	21	22	
8	5	7	8	10	12	13	14	16	17	
9	3	5	6	7	9	10	11	12	13	
10	2	4	4	5	7	8	8	10	10	
T.S.D. = 30 cm.										
"Air" Dose →	100	100	100	100	100	100	100	100	100	100
Skin Dose →	103	109	112	117	120	121	121	123	123	124
0.5 cm.	76	86	91	99	103	104	105	108	110	112
1	60	68	75	86	90	92	93	96	98	100
2	40	48	54	64	69	72	73	76	78	80
3	27	35	40	49	54	56	58	62	63	64
4	19	27	30	37	42	45	46	49	50	51
5	14	20	23	28	33	35	37	40	40	41
6	10	15	17	21	25	27	29	32	32	33
7	7	11	12	16	19	21	22	26	26	28
8	6	8	9	12	15	16	17	20	21	22
9	4	6	7	9	11	12	14	15	16	18
10	3	5	5	7	9	10	11	12	13	14

TABLE X: DEPTH DOSE FOR H.V.L. 4 MM. AL  
(In roentgens per 100 r "in air")

Area in sq. cm. → Diam. in cm. →	1 (1.1)	5 (2.5)	10 (3.6)	25 (5.6)	50 (8)	75 (9.8)	100 (11.3)	200 (16)	300 (20)	400 (22.6)
T.S.D. = 15 cm.										
"Air" Dose →	100	100	100	100	100	100	100	100		
Skin Dose →	103	111	114	120	124	127	128	132		
0.5 cm.	84	94	97	107	111	115	118	122		
1	68	78	81	94	99	104	106	111		
2	47	54	60	73	78	82	83	89		
3	34	39	44	55	61	64	67	71		
4	24	28	32	42	48	50	53	55		
5	17	20	24	31	37	39	41	44		
6	12	15	18	23	27	30	31	34		
7	9	11	13	17	20	22	23	27		
8	6	8	10	13	15	17	18	21		
9	5	6	7	10	12	13	15	17		
10	3	5	6	7	9	10	11	13		
T.S.D. = 20 cm.										
"Air" Dose →	100	100	100	100	100	100	100	100	100	
Skin Dose →	103	111	114	120	124	127	128	132	134	
0.5 cm.	85	94	98	108	113	117	119	123	127	
1	70	81	84	97	103	107	109	115	118	
2	50	58	63	77	83	87	89	95	98	
3	37	43	48	61	67	70	73	77	80	
4	27	31	36	47	53	56	59	62	65	
5	19	23	27	36	42	45	46	50	52	
6	14	17	20	27	31	35	36	40	42	
7	10	13	15	20	24	26	28	32	34	
8	8	10	12	15	18	20	22	25	28	
9	6	8	9	12	14	16	18	21	23	
10	4	6	7	9	11	13	14	17	18	
T.S.D. = 30 cm.										
"Air" Dose →	100	100	100	100	100	100	100	100	100	100
Skin Dose →	103	111	114	120	124	127	128	132	134	136
0.5 cm.	87	96	100	111	115	119	121	126	130	132
1	73	83	87	100	106	111	113	119	121	125
2	53	61	67	82	88	92	94	101	105	108
3	40	47	52	66	73	76	79	84	87	90
4	30	35	40	53	59	63	65	69	72	75
5	22	26	31	41	48	51	53	57	60	63
6	17	20	24	31	36	40	42	46	49	52
7	12	16	18	24	28	31	33	38	41	44
8	9	12	14	19	22	25	26	31	34	37
9	7	9	11	15	18	20	22	26	28	30
10	5	7	9	12	14	16	17	21	23	24



TABLE XI: DEPTH DOSE FOR H.V.L. 8 MM. AL (0.44 MM. CU)  
(In roentgens per 100 r "in air")

Area in sq. cm. → Diam. in cm. →	1 (1.1)	5 (2.5)	10 (3.6)	25 (5.6)	50 (8)	75 (9.8)	100 (11.3)	200 (16)	300 (20)	400 (22.6)
T.S.D. = 15 cm.										
"Air" Dose →	100	100	100	100	100	100	100	100		
Skin Dose →	103	111	115	121	128	131	134	138		
0.5 cm.	86	93	101	110	118	121	125	130		
1	73	79	87	100	109	113	116	123		
2	53	62	68	82	91	96	99	106		
3	39	48	54	65	75	80	84	90		
4	29	38	42	51	61	65	69	75		
5	21	28	32	39	48	53	56	61		
6	16	22	25	31	37	41	45	50		
7	12	17	19	23	29	33	36	40		
8	9	13	15	19	23	26	28	33		
9	7	10	11	14	19	21	23	27		
10	6	7	9	11	15	17	18	22		
T.S.D. = 20 cm.										
"Air" Dose →	100	100	100	100	100	100	100	100	100	
Skin Dose →	103	111	115	121	128	131	134	138	140	
0.5 cm.	87	94	101	112	119	122	127	132	135	
1	75	82	91	103	112	117	120	127	130	
2	56	65	72	87	97	102	106	112	117	
3	43	52	58	71	81	88	91	98	100	
4	32	42	46	57	68	73	77	83	85	
5	24	32	37	45	54	60	64	69	71	
6	19	25	29	36	43	48	52	57	61	
7	14	19	22	28	34	39	42	48	51	
8	11	15	17	22	28	31	34	40	43	
9	8	12	14	18	23	25	28	33	37	
10	7	9	11	14	18	20	22	27	30	
T.S.D. = 30 cm.										
"Air" Dose →	100	100	100	100	100	100	100	100	100	100
Skin Dose →	103	111	115	121	128	131	134	138	140	142
0.5 cm.	88	96	104	114	122	125	129	135	137	140
1	77	84	93	107	116	120	124	131	134	138
2	60	69	77	92	103	108	112	119	124	128
3	46	57	63	77	89	95	99	107	109	112
4	36	47	52	64	75	81	86	93	95	98
5	28	37	42	51	62	69	73	79	82	85
6	22	29	33	42	51	56	61	67	71	74
7	17	23	27	33	41	46	51	57	61	64
8	13	18	21	27	34	38	42	48	52	54
9	10	15	17	22	28	31	34	41	46	48
10	8	12	13	18	23	26	28	34	38	41
T.S.D. = 40 cm.										
"Air" Dose →	100	100	100	100	100	100	100	100	100	100
Skin Dose →	103	111	115	121	128	131	134	138	140	142
0.5 cm.	89	97	105	115	123	126	131	136	139	141
1	79	86	95	109	118	123	127	133	137	141
2	62	71	79	95	106	111	116	123	128	132
3	49	60	67	81	93	101	104	112	115	118
4	39	50	55	68	81	87	92	99	102	105
5	30	40	46	56	67	74	79	86	88	91
6	24	32	36	45	55	61	66	73	78	80
7	19	26	29	36	45	51	56	63	70	71
8	15	21	24	30	38	42	47	54	58	61
9	12	16	19	25	32	35	39	46	52	54
10	10	13	15	20	26	29	32	39	43	46

TABLE XII: DOSAGE CALCULATION  
(Diameter of field 2.5 cm. Dose in roentgens)

H.V.L. → Kv.p. → Filter → T.S.D. →	1.0 mm. Al 100 0 15 cm. 30 cm.	2.0 mm. Al 100 1.0 mm. Al 15 cm. 30 cm.	4.0 mm. Al 120 2.5 mm. Al 15 cm. 30 cm.	8.0 mm. Al* 135 0.25 mm. Cu + 1.0 mm. Al 15 cm. 30 cm.
Air Dose	13,100 11,600	9,540 8,470	7,420 6,570	6,450 5,720
Skin Dose	13,600 12,100	10,200 9,070	8,160 7,230	7,230 6,400
2 cm.	4,000 4,000	4,000 4,000	4,000 4,000	4,000 4,000
5 cm.	1,180 1,360	1,450 1,670	1,480 1,710	1,850 2,140
10 cm.	180 240	270 370	340 480	480 670
Back-scatter Factor	1.04	1.07	1.10	1.12

\* H.V.L. = 0.44 mm. Cu.

TABLE XIII: COMPARISON OF DEPTH DOSE DATA OBTAINED BY VARIOUS AUTHORS

Author*	Phantom	Kv.	Cu (mm.)	Al (mm.)	H.V.L. (mm. Al)	T.S.D. (cm.)	Depth Dose (In roentgens per 100 r at skin)								
							2 Cm. Depth			5 Cm. Depth			10 Cm. Depth		
							10 cm. <sup>2</sup>	50 cm. <sup>2</sup>	100 cm. <sup>2</sup>	10 cm. <sup>2</sup>	50 cm. <sup>2</sup>	100 cm. <sup>2</sup>	10 cm. <sup>2</sup>	50 cm. <sup>2</sup>	100 cm. <sup>2</sup>
Q.	Masonite	100	...	0	0.9	15	32	38	40	11	14	15	..	..	..
B.	Water	100	...	0	1.0	15	32	39	41	10	13	15	..	..	..
Q.	Masonite	100	...	1	2.0	30	47	55	59	21	26	30	..	..	..
R.&G.	Masonite	...	...	...	2.0	30	...	...	...	26.2	33	36	7	10	12
B.	Water	100	...	1	2.0	30	48	58	60	21	27	30	5	7	9
Q.	Masonite	120	...	3	4.3	30	62	72	76	30	39	44	..	15	17
R.&G.	Masonite	...	...	...	4.0	30	..	..	..	31	40	44	10	15	18
B.	Water	120	...	2.5	4.0	30	59	71	74	27	39	42	8	12	14
Q.	Masonite	140	0.25	1.0	8.6	40	70	83	87	38	50	56	15	22	26
R.&G.	Masonite	...	...	...	8	40	..	..	..	38	50	62	16	25	29.7
B.	Water	135	0.25	1.0	8	40	69	83	86	40	52	59	13	20	24
							3 cm. <sup>2</sup>	20 cm. <sup>2</sup>	300 cm. <sup>2</sup>	3 cm. <sup>2</sup>	20 cm. <sup>2</sup>	300 cm. <sup>2</sup>	3 cm. <sup>2</sup>	20 cm. <sup>2</sup>	300 cm. <sup>2</sup>
L.	Water	140	0.25	0	7—	25	65	76	..	30	39	..	9	14	..
B.	Water	135	0.25	1.0	8	25	60	71	..	28	39	..	8	12	..
W.	Water	127	...	6.0	?	40	..	..	92	..	..	62	..	..	28
B.	Water	135	0.25	1.0	8	40	..	..	91	..	..	63	..	..	31

\* Q. Quimby, E. H. (8). R. & G. Reinhard, M. C., and Goltz, H. L. (10). L. Lamerton, L. F. (5). W. Weatherwax, J. L., and Robb, C. (12). B. Braestrup, C. B. (present paper).

due to differences in homogeneity would be insignificant for the usual therapeutic technics, where the voltage would not differ by more than 20 per cent from the values used in this study.

Table XII also illustrates the practical application of the depth dose figures. If we assume that it is desired to deliver 4,000 r to a point 2 cm. below the skin, the table shows the dose at the other levels for different combinations of distance and ray quality. It will be noted that it is possible to obtain nearly the same depth dose for two different ray qualities by increasing the target-skin distance for the less penetrating radiation. If it is desired to minimize the amount of radiation reaching the underlying healthy tissue and to

reduce the exit dose, a low half-value layer and a short target-skin distance should be used. This, however, may result in an excessive skin dose, and the preferred technic in each case will depend upon which is more important: to reduce the tissue dose above or below the lesion.

#### DISCUSSION

The wide range of depth doses obtained with the four ray qualities used in this study indicates that low- and intermediate-voltage therapy could be carried out more effectively with a limited number of technics. Such simplification would permit better correlation between clinical results and physical factors. Half-value layers of 1.0, 2.0, 4.0, and 8.0 mm. Al,

as proposed by our local group of x-ray physicists and used here, should be sufficient for most clinical purposes. Similarly, two target-skin distances, 15 cm. for small fields (5 cm. or less in diameter) and 30 cm. for large fields, should suffice for the treatment of the majority of superficial lesions.

Our study further indicates that the choice of phantom material should be given thorough consideration before making any kind of depth dose measurements. Masonite presdwood should not be used for radiations produced at less than 200 kv., even if its density is unity. Water simulates human tissue much more closely, and its availability in pure state permits better duplications of results between different laboratories. This is indicated in Table XIII, which shows a comparison of present results with previously published depth dose data. As might be expected, the values obtained with presdwood are, in general, higher than those for water, especially at the greater depths. More significant is the much closer agreement between the authors using water as phantom material. Quimby's back-scatter figures for presdwood are from 3 to 9 per cent higher than those obtained with water in this study, while those of Lamerton, also using water, are 3 to 5 per cent lower. This discrepancy may be accounted for, at least partially, by the variation in field distribution obtained with x-ray tubes of different construction.

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#### REFERENCES

1. ANDREWS, G. C.: *Diseases of the Skin*. Philadelphia, W. B. Saunders Co., 2d ed., 1938.
2. ATLEE, Z. J., AND TROUT, E. D.: A Study of Roentgen-Ray Distribution at 60-140 Kv.P. *Radiology* 40: 375-385, 1943.
3. BRAESTRUP, C. B., AND BLATZ, I. H.: Physical Factors of Low-Voltage "Contact" Roentgen Therapy. *Radiology* 35: 198-205, 1940.
4. FAILLA, G.: Measurement of Tissue Dose in Terms of Same Unit for all Ionizing Radiations. *Radiology* 29: 202-215, 1937.
5. LAMERTON, L. F.: Physical Investigations with 140 kvp. Radiation. *Brit. J. Radiol.* 14: 199-205, 1941.
6. MAYNEORD, W. V., AND LAMERTON, L. F.: Survey of Depth Dose Data. *Brit. J. Radiol.* 14: 255-264, 1941.
7. QUICK, R. S., AND ROBERTS, J. E.: Short Distance X-Ray Therapy with Standard Apparatus: Physical Factors. *Brit. J. Radiol.* 16: 82-85, 1943.
8. QUIMBY, E. H.: Some Practical Considerations Regarding the Employment of Various Qualities of Roentgen Rays in Therapy. *Radiology* 38: 261-272, 1942.
9. QUIMBY, E. H., MARINELLI, L. D., AND FARROW, J. H.: A Study of Back-Scatter. *Am. J. Roentgenol.* 39: 799-815, 1938.
10. REINHARD, M. C., AND GOLTZ, H. L.: Quality, Area, and Distance Relationship for  $D_5$ ,  $D_{10}$ , and  $D_{15}$ . *Radiology* 40: 293-296, 1943.
11. SPIERS, F. W.: Materials for Depth Dose Measurements. *Brit. J. Radiol.* 16: 90-97, 1943.
12. WEATHERWAX, J. L., AND ROBB, CHARLES: Water Phantom Intensity Measurements of Roentgen Rays Produced by 127,000 Volts. *Am. J. Roentgenol.* 27: 749-754, 1932.



# Regenerative Processes Induced by Gonadotropic Hormones in Irradiated Testes of the Albino Rat<sup>1</sup>

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FROM A REVIEW of the literature it appears that spontaneous regeneration of the seminiferous epithelium following irradiation depends mainly upon (1) the dosage of x-rays used and (2) the interval of time which has elapsed subsequent to irradiation. It was first claimed that a small amount of x-rays, administered in a single dose, would produce a complete and permanent sterilization (1), but further and more accurate investigation has shown that the spermatogenic function can be permanently suppressed only by doses which seriously injure the interposed and neighboring tissues. The only way in which irrevocable sterilization can be produced without causing serious lesions of the skin and mucous membrane is to divide the total amount of radiation into several fractions. This has been clearly demonstrated by the basic experiments of Regaud and Ferroux (2).

The conception of the interval following irradiation has also changed. In the earlier experiments, the time allowed between irradiation and autopsy was one to three months. In later investigations it was learned that a longer interval was necessary to prove beyond question that sterilization had occurred, the period being first increased to four months (3) and later to eight months (4).

Two conditions thus appear to be indispensable: (1) the lapse of an adequate period of time following irradiation, to rule out the possible survival of the most resistant germinative cells; (2) the administration of the x-rays in fractional doses in such a manner as to assure destruction of the least radiosensitive cells.

A number of other factors, such as the spacing of treatments, dosage, quality of x-rays, etc., are probably responsible for the varied results reported in previous experiments.

X-ray-induced injuries to the germinative tissue of the testes can be divided into four successive phases:

1. Degeneration of spermatids, incomplete maturation of spermatozoa, formation of giant cells. The cells already mature are not visibly affected, at least for a certain period of time.
2. Disappearance of spermatids, but no appreciable alteration of spermatocytes, spermatogonia, and Sertoli cells.
3. Degeneration of spermatocytes.
4. Complete denudation of tubules, with a fibrous hyaline thickening of the tubular walls.

Obviously, the possibility of regeneration of the seminiferous epithelium is removed when the last of these four steps is accomplished. In most of the previously reported experiments, the degenerative changes did not reach the fourth stage.

Regeneration of germinal epithelium presumably takes place (a) in certain so-called "indifferent" or undifferentiated cells which are capable of transformation into either spermatogonia or Sertoli cells (5); (b) in Sertoli cells after a preliminary dedifferentiation into an earlier stage of development: a kind of retrogressive metamorphosis (6); (c) from modified spermatogonia which are embedded singly or in groups in the Sertoli syncytium (7). Whatever the type of cell capable of restoring the seminiferous epithelium, the persistence of a layer of cells which are not exactly identified as Sertoli cells, or spermatogonia, or other undifferentiated cells, often leaves in doubt the effectiveness of the sterilization.

<sup>1</sup> From the Department of Anatomy, Loyola University School of Medicine, Chicago, Ill. Accepted for publication in August 1943.

The gonadophysin used in the experiment to be described was generously supplied by G. D. Searle & Co., Chicago.

Bourg (8) was the first to test the action exerted by gonadotropins derived from the urine of pregnant women upon the testes of irradiated rats. He found that irradiation with 1,000 r would not prevent a proliferative response of the interstitial cells, with increased secretion of male hormones and accelerated development of the prostate gland.

The problem was reinvestigated by Johnston (9) who decreased the dosage of x-rays to 300 r, administered at one time. Some of the irradiated animals were injected daily with 5 rat units of antuitrin S, for a period of six weeks. Autopsy followed immediately after the treatment. In the injected animals, as compared with uninjected animals, an increase of 44 per cent in the testicular weight was noted. The increase in the combined weight of the dorsal lobe of the prostate and the seminal vesicles was much greater (95 per cent); a corresponding increase was noticed in the ventral prostate gland. It is interesting to note that while the weight of the accessory organs greatly surpassed that for the unirradiated animals, the weight of the testes remained far below (260 mg. compared with 668 mg. in the controls).

Heald, Beard, and Lyons (10) administered x-rays to immature rats in single doses of 1,152 and 4,608 r. In some animals irradiation was directed to the entire testicle, which was directly exposed through an abdominal incision; in others, only half the organ was irradiated. Treatment with gonadotropic hormones was initiated five days after irradiation. Seven units of prolan were injected daily for five days, and autopsies were done twenty-four hours after the last injection. A pronounced atrophy of the tubules was demonstrated, both in the animals receiving 1,152 r and those receiving 4,608 r. There was degeneration of all but a single layer of cells, most of which were Sertoli cells. The interstitial cells, on the contrary, were stimulated by the hormones, as indicated by the presence of some mitoses even after irradiation with 4,608 r. The weight of the accessory organs was main-

tained; but an increase of 50 per cent was registered when the irradiation was directed to one-half of the testis. The response of the irradiated testes to the gonadotropic hormones was, therefore, essentially negative in so far as regeneration of the seminiferous epithelium is concerned, but positive with reference to the interstitial cells.

The hormones used in the experiments mentioned above were extracted from the urine of pregnant women. No investigations have been reported in which pituitary gonadotropins were employed. It is interesting to note that, in the case of the ovary, the action of the urinary gonadotropins is not limited to a stimulation of the theca cells or of the interstitial tissue, but seems to include a real regeneration of the follicular system. Nürnberger (11) has noticed, for instance, the presence of follicles in the rat ovary which later were transformed to corpora lutea, 195 days after irradiation with a dosage three times as intense as the castration dose for rats. Using large amounts of horpan and prolan, Heimann (12) has obtained not only a regeneration of the follicles in guinea-pigs but, in due time, fecundation of some of the irradiated animals.

In view of the more complex and probably the more elective action of the gonadotropic hormones extracted from the prehypophysis, we thought it would be of value to study their effect on irradiated testes. The experiments recorded here were carried out for that purpose.

#### MATERIAL AND METHODS

The gonadotropins derived from the urine of pregnant women or women in the menopause, or from chorionic tissue and mare's serum, do not exert a definite stimulating effect on the proliferation of the germinative cells. As seen in experiments involving hypophysectomy, avitaminosis, ligation of the spermatic arteries, vasectomy, cryptorchidism, etc., the action of these gonadotropins appears uncertain and often contradictory. Their influence seems limited mainly to the interstitial

cells, which respond with an enhanced proliferation and an increased secretory activity. This explains the increase of weight and volume of the accessory organs in all these experiments. A direct action on the tubules has been specifically denied by Collip, Selye, and Thomson (13).

The gonadotropic hormones derived from pituitary sources show a definite action on the seminiferous epithelium. The follicle-stimulating fraction, for example, acts upon the tubular system of the testes, as is demonstrated by the reparative influence exerted after hypophysectomy (14, 15, 16). This stimulating influence seems to involve only the tubular development; no changes are evident in the interstitial tissue. The luteinizing hormone, on the other hand, affects only or mainly the interstitial tissue, which explains the large increase in volume of the accessory organs both in normal animals and animals in which the tubular system has undergone degenerative processes. The simultaneous injection of the follicle-stimulating and the luteinizing hormones activates both the tubules and the interstitial cells.

In order to test the response of irradiated testes to a gonadotropic hormone containing both the follicular and the luteinizing fraction, gonadophysin, an extract of the anterior lobe of the pituitary of sheep (produced by G. D. Searle & Co.) was used in our experiments. White rats were first irradiated at the age of 30 days. These animals were sexually immature, since adult spermatozoa have not been found in rats before the age of 40 or 42 days.

The x-ray machine was mechanically rectified and provided with a Landauer roentgenometer. A universal Coolidge therapy tube was used. The set-up of the machine for the entire investigation was as follows: The kilowatt-meter was set at 96, which delivered 112 kv.p. as measured by the sphere gap; the focal distance was 10 in. The filter was equivalent to 4 mm. aluminum. The roentgenometer was kept at 3.2 ma., which, by calculation, gave 0.6 r per second. The desired dosage was obtained by varying the time of exposure.

A preliminary investigation has shown that the x-ray dosage necessary for complete sterilization of the testes of white rats ranges between 800 and 1,000 r, provided the total amount is divided into three or four fractions separated by an interval of not more than five days. The same dosage administered at one time produces a partial and often moderate sterilization.<sup>2</sup> The explanation of these different results probably lies in the fact that the most refractory cells are the spermatogonia, and that only part of these are in a stage of reproductive activity, and therefore radiosensitive, at the time of irradiation. The fractionation of the dosage should be effected in such a way as to injure the spermatogonia when they pass from a stage of inactivity to a stage of proliferation, according to a certain rhythm of mitosis (18, 19). For this reason, the total dose of x-rays has been divided into three fractions, separated by an interval of five days.

The testes were drawn from the abdominal cavity into the scrotal sac by constricting tape and were then irradiated, the animals being strapped, back down, on a specially constructed board and protected during irradiation by a sheet of lead. Testes and accessory organs were fixed in Bouin picric acid solution and weighed after twenty-four hours. The dissection of the accessory organs was performed in such a way as to isolate the ventral and dorsal lobes of the prostate, the coagulating gland, and the seminal vesicles. The organs were embedded in paraffin and were stained with eosin-hematoxylin.

In all, 80 animals were used, for these studies. They were classified in the following groups:

GROUP I: Untreated controls (27 animals)

- A. Four rats. Autopsy at 30 days of age.
- B. Six rats. Autopsy at 40 days of age.
- C. Five rats. Autopsy at 60 days of age.
- D. Six rats. Autopsy at 90 days of age.
- E. Six rats. Autopsy at 120 days of age.

<sup>2</sup> In the experiment of Hertwig (17) only 12 per cent of the animals irradiated with 800 r, given at one time, showed complete sterilization.

GROUP II: Treated with x-rays (800 r) at 30, 35, and 40 days of age; uninjected (25 animals.)

- A. Six rats. Autopsy after final x-ray treatment, at 40 days of age.
- B. Six rats. Autopsy at 60 days of age.
- C. Six rats. Autopsy at 90 days of age.
- D. Seven rats. Autopsy at 120 days of age.

GROUP III: Treated with x-rays (800 r) at 30, 35, and 40 days of age and injected with gonadophysin. Autopsy at 120 days of age (18 animals.)

- A. Six rats injected twice weekly, 10 R.U. per injection, from time of first x-ray treatment until autopsy. Total amount of gonadophysin 260 R.U.
- B. Six rats injected twice weekly, 10 R.U. per injection, from 60 days of age until autopsy. Total amount of gonadophysin 180 R.U.
- C. Six rats injected daily, 10 R.U. per injection, during the last 10 days before autopsy.

GROUP IV: Treated with x-rays at 30, 35, and 40 days of age (800 r) and injected with testosterone propionate. Autopsy at 120 days.

- A. Six rats injected daily with 1 mg. testosterone propionate (Oreton, Schering) during the last 10 days before autopsy.

GROUP V: Surgically castrated at the age of 30 days. Autopsy at 120 days.

- A. Six rats.

#### RESULTS IN IRRADIATED, UNINJECTED ANIMALS

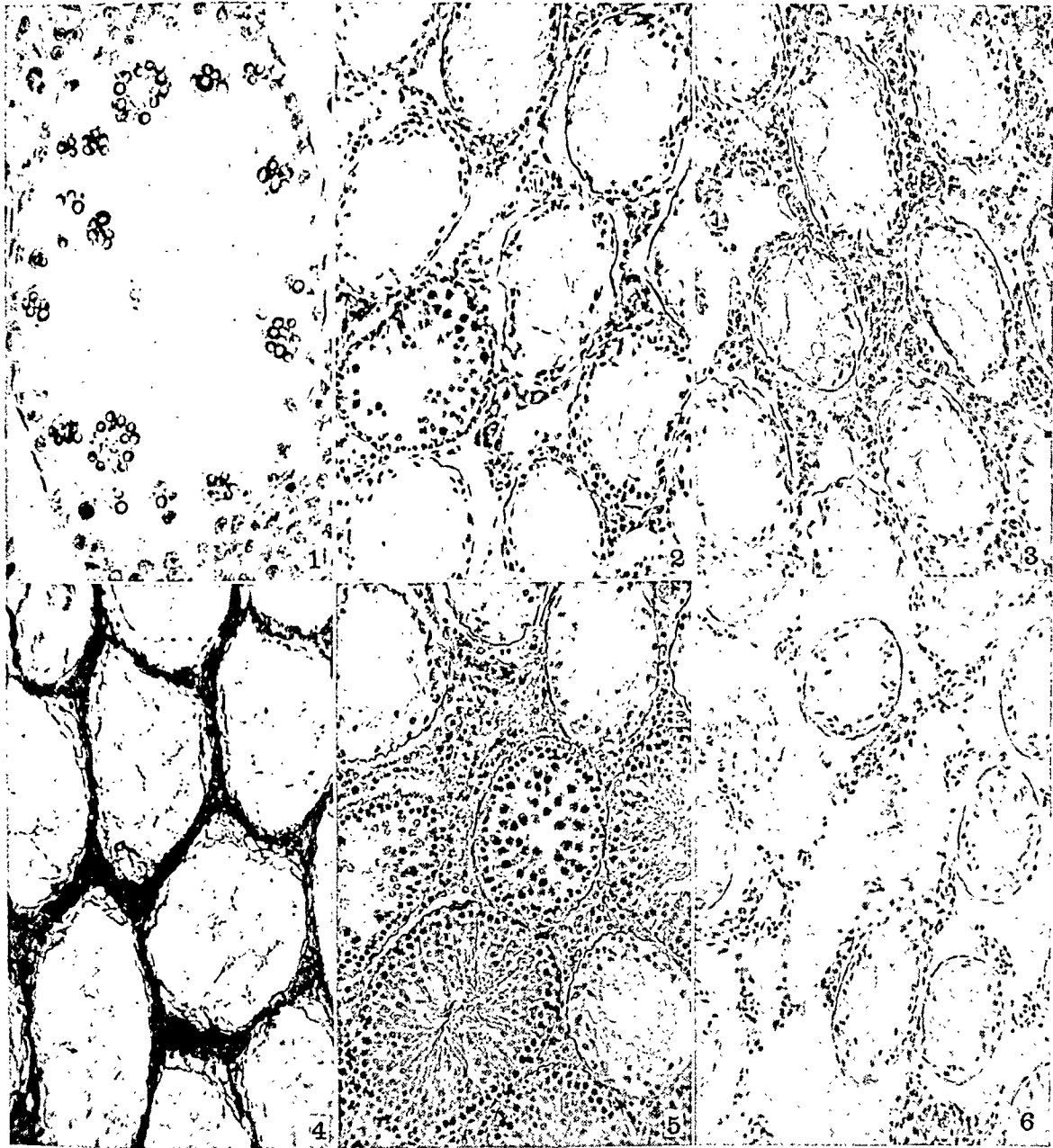
The microscopic changes in the animals treated by irradiation alone show a definite relation to the interval elapsing after the irradiation. The rate of the degenerative process, however, varies considerably in the different groups studied.

*Autopsy Immediately after the Last Irradiation (at 40 Days of Age):* The irregular distribution of the degenerative changes is particularly evident in the animals autopsied at 40 days of age, immediately following the last irradiation. Tubules completely denuded or lined by a single layer of spermatogonia are intermixed with tubules which reveal no degenerative changes, or even active spermatogenesis. Apparently normal tubules are surrounded by others which are slightly injured, with the persistence of several strata of spermatocytes. Contrary to what some investigators have claimed, spermatogonia seem to be the most refractory cells. Spermatids, on the contrary, are

the most radiosensitive, as shown by the early appearance of degenerative changes of the nuclei (pyknosis, chromatolysis, chromatorhexis). The degeneration of both spermatids and spermatocytes is often accompanied by the appearance of giant cells, some containing 10 or more nuclei (Fig. 1).

The occurrence of giant cells in degenerating tubules has been noticed not only after irradiation (20), but under various other experimental conditions, namely, following injections of iodine and alcohol (21), after thermal or mechanical injuries (22), after administration of thymus extracts (23) or estrogenic hormones (24), in conditions of A or B avitaminosis (25), after ligation of the spermatic vessels (26). It is generally conceded that these cells arise from the fusion of spermatids and spermatocytes desquamated in the tubular cavity. In fact, degenerating cells in the interior of the tubules have a tendency to melt together, so as to bring about the formation of plasmodial or syncytial masses. This is confirmed by the microscopic aspects noticed in our slides, that definitely point to a degenerative origin of the giant cells. No noticeable changes occur in the interstitial cells. Blood vessels appear normal.

*Autopsy Twenty Days after Irradiation (at 60 Days of Age):* Twenty days after irradiation the degenerative changes have progressed further. They now involve all the spermatocytes and sometimes the spermatogonia, also. The majority of the tubules are lined only by one or two layers of cells, represented by spermatogonia and Sertoli cells. Cellular debris is found in the lumen, mixed with degenerating cells, while plasmodial masses are rare. Even after this period of time tubules only slightly injured, or tubules in which regenerative processes are under way, can be found. They are seen alone or in groups between degenerated tubules (Fig. 2). The spermatocytes look normal or even show some mitosis. An active proliferation of spermatogonia takes place in other tubules, especially in those with a dark, crusty



Figs. 1-6. Effects of irradiation, with and without hormone administration, on testes of the white rat.  
Fig. 1. Degenerative changes observed immediately after irradiation.  
Fig. 2. Progressive degenerative changes accompanied by some evidences of regeneration, 20 days after irradiation.  
Fig. 3. Changes at 50 days after irradiation.  
Fig. 4. Terminal stage of degeneration, with complete denudation of tubules, 80 days after irradiation.  
Fig. 5. Regenerative changes in animal receiving gonadophysin after first irradiation, 80 days after completion of irradiation.  
Fig. 6. Changes in irradiated animal injected with testosterone propionate (Oreton).

nucleus (the so-called "sporecells"). In still others, a large number of secondary spermatocytes are noticeable, in spite of the absence of spermatids. It is difficult, if not impossible, to determine whether

the seminiferous epithelium lining these tubules has escaped the destructive action of the x-rays or is the result of regeneration. In the latter event, the regeneration is confined to proliferation of and



transformation of spermatogonia into spermatocytes. Spermatogenesis never reaches a further stage.

Sertoli cells appear normal and sometimes more numerous than in the controls, *i.e.*, the non-irradiated animals. The interstitial tissue shows here and there hyperplastic and hypertrophic changes. Instead of a thin layer of cells between the tubules, thickly packed epithelioid cells are found. They usually lie in groups around the blood vessels. In other places, a clear, colloid-like liquid has infiltrated the intertubular spaces, with a rarefaction of the stroma.

*Autopsy Fifty Days after Irradiation (at 90 Days of Age)*: The tubules at fifty days after irradiation are lined by a single layer of spermatogonia and Sertoli cells. Spermatocytes and spermatids have disappeared or are found only in the cavity of the tubules. The differentiation of spermatogonia from Sertoli cells is difficult, on account of the vagueness of the cellular limits. The epithelial layer has a plasmodial aspect; a few relatively large and pale nuclei are irregularly distributed in the cytoplasm. The inner border of the cytoplasm is often interrupted by the elimination of cellular fragments in the tubular cavity. The interstitial tissue is more abundant, partly as the result of an increase of the interstitial cells and partly because of a proliferation of the stroma (Fig. 3). The hyperplastic changes of interstitial cells are, however, uneven and seldom reach a great intensity. No vascular changes are found.

*Autopsy Eighty Days after Irradiation (at 120 Days of Age)*: In some animals the degeneration of the tubules at eighty days after irradiation corresponds approximately to that at fifty days. In others, the degeneration has reached what can be considered the terminal and probably the permanent stage of sterilization, with a complete denudation of the tubules (Fig. 4). Such a sterilization is comparatively rare with a total fractionated dose of 800 r. It becomes relatively common when the dose is increased. A dosage of 800 r

divided into three fractions can be considered a sublethal dose. It is very close to the one necessary to destroy completely the seminiferous epithelium, including the Sertoli cells.

In the areas where the tubules are denuded, the interstitial tissue is thickened. Epithelioid cells are somewhat rare and without signs of proliferation. Instead, the connective tissue is dense and compact, forming a honey-combed net around the denuded tubules. Zones of edema and of hyaline degeneration occur irregularly. Vascular changes are sometimes evident, mostly in the form of an obliterative endarteritis.

#### RESULTS IN IRRADIATED ANIMALS INJECTED 'WITH GONADOPHYSIN

In animals injected with gonadophysin, the results differ in accordance with the time the treatment started. In the animals injected immediately following the first irradiation, the degenerative processes have given way to a rapid and extensive regeneration of the seminiferous epithelium. Figure 5 shows the different aspects of the tubules 80 days after irradiation. Intermixed with tubules gravely injured and lined only by an incomplete syncytial layer are other tubules lined by several layers of germinative cells in successive stages of differentiation. The proliferation of the newly formed cells is followed by a nearly perfect maturation, as shown by the presence of many spermatids and occasionally even of spermatozoa. The regeneration of the seminiferous epithelium never extends to all the tubules at the same time. It appears to originate from certain points and spreads thereafter to the neighboring tubules.

Microscopically, no marked difference has been noted between animals injected immediately after the first irradiation and those injected fifteen days after the last irradiation. The weight of the testes, however, varies in the two series, being greater in the first series.

In every case the number and size of the interstitial cells appear to be noticeably

TABLE I: WEIGHT OF TESTES AND ACCESSORY ORGANS IN CONTROL AND IRRADIATED ANIMALS

Age at Autopsy	Testes (Mg.)	Seminal Vesicle (Mg.)	Lobes of Prostate			Body Weight (Gm.)
			Ventral (Mg.)	Dorsal (Mg.)	Cranial (Mg.)	
40 days						
Controls	731	16	39	28	7	81
Irradiated	629	28	62	49	9	123
60 days						
Controls	1,016	24	51	34	9	102
Irradiated	557	77	88	58	34	133
90 days						
Controls	1,903	91	125	74	26	150
Irradiated	508	197	181	139	66	201
120 days						
Controls	2,785	614	655	347	213	287
Irradiated	534	256	169	129	71	283
Irradiated and in- jected with Gonadophysin*						
(a)	731	238	190	199	95	257
(b)	467	442	333	237	116	266
(c)	728	353	286	169	108	256
Irradiated and in- jected with Ore- ton	504	840	648	382	212	266
Surgical castration at 30 days of age	...	11	11	8	...	245

\*(a) Injection started immediately after first irradiation. (b) Injection started 15 days after last irradiation. (c) Injection started 65 days after last irradiation.

increased. It seems that the interstitial tissue retains the capacity to respond to the stimulating influence of the gonadotropic hormones for a longer period of time. Hyperplastic and hypertrophic changes of the interstitial cells are more intense than in untreated animals and are present even when the seminiferous epithelium has been so gravely injured as to preclude any possibility of regeneration.

#### RESULTS IN IRRADIATED ANIMALS INJECTED WITH ORETON

The tubules in most of the animals injected with testosterone propionate (Oreton) are lined by only a few scattered Sertoli cells and degenerating germinative cells. The lumen is packed with cellular debris and a network of small hyaline bands. Proliferative changes of the interstitial tissue, if present, are generally masked by a large accumulation of a clear, homogeneous liquid between the involuting tubules (Fig. 6).

Blood vessels are apparently not affected by the irradiation. The presence of a large quantity of a colloid-like liquid in the interstitial tissue is probably second-

ary to the involution of the tubules and to the reabsorption of the liquefied cells into the lymphatic spaces.

#### DISCUSSION

In the accompanying table the average weight of the testes and of the accessory organs of the various series of white rats used in this experiment is reported. It will be noted that the progressive atrophy of the testes does not extend to the accessory organs for a long period of time. Although the weight of the testes shows a definite effect of the x-rays, with a notable decrease after even a few days, the weight of the accessory organs largely exceeded that of the controls for six weeks after irradiation. From then on, the weight of the seminal vesicles and of the prostate showed a sharp decline, while in the controls the weight was rapidly increasing.

The varied response of testes and accessory organs to x-rays is well known. Practically all of the experiments to date agree that the destruction of the seminiferous epithelium does not include the sources which provide the male hormone and, therefore, the stimulating factors for

the development of the accessory organs (27, 28). If the hyperplastic and hypertrophic changes noticed in the accessory organs after irradiation can be taken as indicators of the activity of the interstitial cells of the testes, it appears certain that these cells constitute the main source of the male sex hormone.

Surgical and x-ray castration differ in their effects on the accessory organs. Surgical castration not only prevents the development of the accessory organs, but brings them back to an infantile stage (Table I).

In irradiated animals, the response of the accessory organs to androgenic hormones is much more intense than to gonadotropic hormones. In both instances, the seminal vesicles and the prostate are enlarged, but more so with androgenic hormones. On the contrary, gonadotropic hormones show a tendency to increase the weight of the atrophic testes, while testosterone does not.

The possibility of stimulating the accessory organs with testosterone, after x-ray castration, is not surprising, since the stimulation is a direct one, as proved by corresponding results in surgically castrated animals. Also the lack of (structural) changes in irradiated testes is to be expected, as with few exceptions androgenic hormones do not exert a manifest action either on the seminiferous epithelium or on the interstitial cells. When some changes are evident, these are of a retrogressive nature (29). Furthermore, androgenic hormones do not show any favorable influence on the regeneration of the seminiferous epithelium injured by starvation, avitaminosis, hypophysectomy, estrogenic hormones, etc. If the treatment is started when the degeneration of the seminiferous epithelium has not progressed too far, spermatogenesis is maintained (30).

The stimulation of the regenerative processes by pituitary gonadotropins is interesting since it is the first exact demonstration of this kind. In the investigation of Johnston (9), only the weights of the testes and of the accessory organs were

reported, while Bourg (8) and Heald, Beard, and Lyons (10) noticed an enlargement of the accessory organs as a consequence of proliferative changes of the interstitial cells. The regeneration of the seminiferous epithelium is very similar to that promoted by gonadotropic hormones after hypophysectomy or by the administration of Vitamins A, B and E after a temporary deficiency, or following an excess of androgenic or estrogenic hormones. Complete data can be found in a paper by Bail (24).

If the testes are irradiated with less excessive doses of x-rays, the undifferentiated spermatogonia survive the injury. We consider these as reserve cells. The persistence of these or other undifferentiated cells is, however, limited to a certain period of time, which explains the dependence of the effects of gonadotropic hormones upon the time of administration.

The participation of Sertoli cells in the regenerative processes seems less probable. Their nuclei are often very irregular and are seldom involved in a process of true mitosis. The polymorphism of Sertoli cells is purely functional and is correlated to spermatogenesis. A certain parallelism between the cyclical changes of the trophic and germinative elements has been, in fact, demonstrated in several investigations (31, 32).

In irradiated testes the transformation of Sertoli cells into a syncytium offers to spermatogonia, embedded in a common cytoplasm, better conditions of nutrition and therefore a greater chance of survival. If regeneration takes place, Sertoli cells resume their individual structure. Spermatogonia can then be readily differentiated from the supporting cells. They enter in a phase of active proliferation, giving rise to spermatocytes. The tubules are relined gradually by several layers of germinative cells. The stage of differentiation reached by the germinative cells varies considerably. Rarely does it exceed the stage of transformation of spermatids into spermatozoa. There is

some reason to believe that a period longer than three months may bring about the reappearance of a large number of spermatozoa, with the possibility of restoring the fertility of the irradiated animals.

The influence exerted by the gonadotropic hormones on the interstitial cells is less evident because of progressive changes occurring after irradiation. It is probable, however, that the interstitial cells are also stimulated by gonadophysin, as shown by the limited decrease of weight of the accessory organs in comparison with untreated animals, from the 50th to the 80th day after irradiation. In this case, it is not a question of regeneration, but of maintenance of the anatomical and functional changes determined by the irradiation.

#### CONCLUSIONS

1. Spontaneous regeneration of the seminiferous epithelium of testes of the albino rat, irradiated with a dose of x-rays not exceeding 800 r, is irregular and incomplete.

2. Recovery is slow with dosages of 800 r and rare with 1,000 to 1,200 r.

3. The destruction of the seminiferous epithelium involves first the spermatoocytes, then the spermatozoa, next the spermatids, and finally the spermatogonia.

4. In spontaneous regeneration, spermatozoa are rarely produced. The newly formed cells are generally limited to the spermatocyte stage.

5. The degeneration of seminiferous tubules is followed by hyperplastic and hypertrophic changes in the interstitial cells. Accessory sex organs show a marked increase in size as contrasted with those of control animals.

6. The changes in the interstitial cells and in the accessory organs in spontaneous regeneration are temporary in nature; in both instances involution follows, 50 to 80 days after irradiation.

7. Gonadophysin, an anterior pituitary gonadotropin, consisting of both the follicle-stimulating and luteinizing fractions, exerts a manifest restorative action on

irradiated testes if injected at or shortly after irradiation and continued for several weeks.

8. The process of regeneration of the seminiferous epithelium of the injected animals surpasses that of uninjected animals in rapidity, extent, and completeness. The germinative cells may reach the stage of spermatozoa.

9. The restorative action of gonadophysin varies indirectly with the extent of x-ray injury and the time and the amount of administration of the hormone.

10. A temporary stimulating effect of gonadophysin on the interstitial cells is in evidence, but it fails to prevent their subsequent atrophy.

11. Testosterone propionate shows no restorative effect on the x-rayed seminiferous epithelium, but it stimulates the interstitial cells and the accessory sex organs.

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#### BIBLIOGRAPHY

1. REGAUD, C., AND NOGIER, T.: Stérilisation complète et définitive des testicules du rat sans aucune lésion de la peau par une application unique de rayons X filtrés. *Compt. rend. Acad. d. sc.* 149: 1398, 1909.

2. REGAUD, C., AND FERROUX, R.: Est-il possible de stériliser le testicule du lapin adulte par une dose massive de rayons X sans produire de lésion grave de la peau? *Compt. rend. Soc. de biol.* 97: 330-333, 1927.

REGAUD, C., AND FERROUX, R.: Discordance des effets des rayons X, d'une part dans la peau, d'autre part dans le testicule, par le fractionnement de la dose. *Compt. rend. Soc. de biol.* 97: 431-434, 1927.

REGAUD, C., AND FERROUX, R.: Influence du "facteur temps" sur la stérilisation des lignées cellulaires normales et néoplasiques par la radiothérapie. *Acta radiol., Suppl.* 3, part 1, 107, 1928.

3. FERROUX, R., REGAUD, C., AND SAMSSONOW, N.: Comparaison des effets produits sur les testicules du lapin, au point de vue de la stérilisation de l'épithélium séminal, par une même dose de rayons X, selon qu'elle a été administrée sans fractionnement ou bien fractionnée et étalée dans le temps. *Compt. rend. Soc. de biol.* 128: 173-176, 1938.

4. FERROUX, R., REGAUD, C., AND SAMSSONOW, N.: Effets des rayons de roentgen administrés sans fractionnement de la dose, sur les testicules du rat, au point de vue de la stérilisation de l'épithélium séminal. *Compt. rend. Soc. de biol.* 128: 170-173, 1938.

5. RÖSSLE, R., AND ZÄHLER, H.: Experimentelle Untersuchungen über Hoden- und Prostataveränderungen durch Zufuhr von Hodenwirkstoffen. *Virchows Arch. f. path. Anat.* 302: 251-300, 1938.

6. SCHINZ, H. R., AND SLOPOULSKY, B.: Experimenteller Beitrag zur Frage der Röntgenallergie. *Acta radiol.* 7: 365-404, 1926.

7. SIMMONDS, M.: Über die Wirkung von Röntgenstrahlen auf den Hoden. Fortschr. a. d. Geb. d. Röntgenstrahlen 14: 229, 1909-10.
8. BOURG, R.: Recherches sur l'histophysiologie de l'ovaire, du testicule et des tractus génitaux du rat et de la souris. Arch. de biol. 41: 245-341, 1931.
9. JOHNSTON, R. L.: Studies in the Physiology of the Prostate Gland. Endocrinology 18: 123-141, 1934.
10. HEALD, A. H., BEARD, C., AND LYONS, W. R.: Effects of Roentgen Radiation and Prolan upon the Testes of Immature Rats. Am. J. Roentgenol. 41: 448-452, 1939.
11. NÜRNBERGER, L.: Aschheim-Zondek'sche Schwangerschaftsreaktion und Röntgenstrahlen. Zentralbl. f. Gynäk. 59: 722-726, 1935.
12. HEIMANN, F.: Die Beeinflussung strahlengeschädigte Ovarien durch das Hormon des Hypophysenvorderlappens. Zentralbl. f. Gynäk. 59: 83-90, 1935.
13. COLLIP, J. B., SELYE, H., AND THOMSON, D. L.: Gonad-Stimulating Hormones in Hypophysectomised Animals. Nature 131: 56, 1933.
14. COLLIP, J. B., SELYE, H., AND THOMSON, D. L.: Histological Changes in Hypophysis Produced by Chronic Administration of Hypophyseal Extracts. Proc. Soc. Exper. Biol. & Med. 31: 682-683, 1933.
15. GREEP, R. O., FEVOLD, H. L., AND HISAW, F. L.: Effects of Two Hypophyseal Gonadotropic Hormones on the Reproductive System of the Male Rat. Anat. Rec. 65: 261-271, 1936.
16. GREEP, R. O., AND FEVOLD, H. L.: Spermatogenic and Secretory Function of the Gonads of Hypophysectomized Adult Rats Treated with Pituitary FSH and LH. Endocrinology 21: 611-618, 1937.
17. RUBINSTEIN, H. S., AND ABARBANEL, A. R.: Effects of Anterior Pituitary Extract on Spermatogenesis in Rat. J. Urol. 41: 773-779, 1939.
18. HERTWIG, P.: Die Regeneration des Samenepithels der Maus nach Röntgensbestrahlung, unter besonderer Berücksichtigung der Spermatogonien. Arch. f. exper. Zellforsch. 22: 68-73, 1938.
19. LANGENDORFF, H.: Über die Wirkung einzeitig verabreichter Röntgendosen auf den rhythmischen Verlauf der Spermatogonienteilung im Mäusehoden. Strahlentherapie 55: 58-71, 1936.
20. SCHINZ, H. R., AND SLOPOLSKI, B.: Beiträge zur experimentelle Pathologie des Hodens und zur Histologie und Histogenese des normalen Hoden, der Hodenatrophie und Hodennekrose. Denkschr. d. Schweiz. Naturf. Ges. 61: Abt. II, 29, 1924.
21. BLANC, A.: Action des rayons X sur le testicule. Thèse de Lyon, 1906.
22. ADLER, L.: Über Jodschädigungen der Hoden. Arch. f. exper. Path. 75: 362, 1914.
23. MAXIMOW, E.: Die histologischen Vorgänge bei der Heilung von Hodenverletzungen und die Regenerationsfähigkeit des Hodengewebes. Beitr. z. path. Anat. u. z. allg. Path. 26: 230, 1899.
24. GRANEL, B.: Les corrélations thymo-testiculaires. Montpellier méd. 11: 203-211, 1937.
25. BAIL, A.: Über die durch Follikelhormon hervorgerufene Atrophie der männlichen Keimdrüsen und ihre Regenerationsfähigkeit. Frankfurt. Ztschr. f. Path. 55: 14-38, 1941.
26. KÜTTNER, H.: Vitamin A-Mangel und Keimdrüsen (Versuche an Ratten). Frankfurt. Ztschr. f. Path. 54: 133-150, 1939-40.
27. MAATZ, R.: Ueber die anatomischen Folgen vorübergehender Gefäßabklemmung an Hoden. Zentralbl. f. allg. Path. u. path. Anat. 59: 243-249, 1934.
28. HU, C. K., AND FRAZIER, C. N.: Atrophy of Germinal Epithelium of the Rabbit's Testis Induced by Roentgen Rays. Proc. Soc. Exper. Biol. & Med. 48: 44-48, 1941.
29. WITSCHI, E., LEVINE, W. T., AND HILL, R. T.: Endocrine Reactions of X-ray Sterilized Males. Proc. Soc. Exper. Biol. & Med. 29: 1024-1026, 1932.
30. MOORE, C. R., AND PRICE, D.: Some Effects of Synthetically Prepared Male Hormone (Androsterone) in the Rat. Endocrinology 21: 313-329, 1937.
31. MOORE, C. R., AND PRICE, D.: Some Effects of Testosterone and Testosterone-Propionate in the Rat. Anat. Rec. 71: 59-78, 1938.
32. HAMILTON, J. B., AND LEONARD, S. L.: Effect of Male Hormone Substance upon Testes and upon Spermatogenesis. Anat. Rec. 71: 105-117, 1938.
33. FRORIEP, E.: Zur Frage der Sertoli'schen Zellen. Anat. Anz. 82: 1-20, April 24, 1936.
34. ROLSHOVEN, E.: Die funktionelle Polymorphie des Sertoli-Syncytiums und ihr Zusammenhang mit der Spermatogenese. Ztschr. f. Zellforsch. u. mikr. Anat. (Abt. A) 31: 156-164, 1940.

## CASE REPORTS

### Total Subphrenic Abscess<sup>1</sup>

DAVID V. LeMONE, M.D.  
and WILLIAM GRANT COOPER, Jr., M.D.  
Columbia, Mo.

Manifest subphrenic abscess generally occurs as an accumulation of pus in one or two of the numerous peritoneal pockets found between the diaphragm and the mesocolon. A large number of the subdivisions of this space may be involved, but such patients rarely survive the infection. In general, the mortality for undrained subphrenic abscess is around 90 per cent (1). The rupture of duodenal ulcers and of gastric lesions accounts for about 27 per cent of all these infections (2), and the longer the interval between perforation and proper treatment, the graver the prognosis. An occasional case of complete left-sided subphrenic abscess is recorded (3), and one bilateral abscess is reported by Osborne (4). We have recently seen a patient who recovered from a rather large subphrenic abscess, originating from the rupture of a peptic ulcer and present for six weeks before definitive therapy. Roentgenologically, and at operation, the process involved most of the available intraperitoneal spaces.

The anatomy of this area is briefly as follows (5): The falciform ligament sagittally divides the subphrenic space into two parts, the right and the left. Each side is again divided by the lateral ligament of the liver into a larger anterior and a smaller posterior zone. [Faxon (2) states that the left lateral ligament is so posteriorly placed that no posterior subphrenic space exists on that side.] The unperitonealized superior hepatic surface between these ligaments is in another separate compartment. Although not strictly subphrenic, the regions immediately below the liver are generally included because of

their frequent concomitant involvement in any infectious process of this type. This subhepatic, supramesocolic space is also divided sagittally in the mid-line by the ductus venosus and the round ligament. The right subhepatic space, thus formed, connects through the foramen of Winslow with the left posterior subhepatic space, which is partitioned off from the left anterior subhepatic space by the gastrohepatic ligament. The rupture of a duodenal ulcer, because of its anatomical site of origin, frequently gives rise to infection restricted to the right posterosuperior, the right anterosuperior, and the right inferior subdiaphragmatic spaces.

#### CASE REPORT

W. J., a 58-year-old white, married American farmer, was first seen Oct. 28, 1942, complaining of incapacitating abdominal distress. Fifteen years earlier an attack occurred characterized by vague postprandial pain, nausea, and the vomiting of bile, but it was entirely relieved by soda. A symptom-free interval of twelve years was then followed by recurrences of increasing severity and frequency. Five weeks prior to admission, the present acute attack began as a sudden prostrating illness, with violent nausea and abdominal cramps without localization. The patient took five 1-gr. calomel tablets every two hours the first night and then a large dose of salts. The next morning he was prostrated with indefinite, oppressive sickness and mild epigastric pain. Since then, he had continuously vomited small amounts of sour yellow fluid, uncolored by fresh or old blood. One of 6 stools in thirty days was black. His weight had fallen from 130 to 100 pounds. Respiratory symptoms were absent.

The family history and past history were not contributory except for recording the daily consumption of from one to two pints of whisky for years, until the onset of the present illness five weeks ago.

The patient appeared fairly well developed, poorly nourished, and asthenic, without evidence of great distress. Vital signs were normal. The skin was dry and there was little subcutaneous fat, although cachexia was not severe. Examination of the heart and lungs revealed no abnormality except for questionable fixation of the diaphragm. Blood pressure was 90/56. The abdomen showed slight, diffuse muscle guard in the epigastrium and right upper quadrant, but rigidity and rebound tenderness were absent.

<sup>1</sup> From the Diagnostic, Roentgenological, and the Surgical Departments of the Ellis Fischel State Cancer Hospital, Columbia, Mo. Accepted for publication in August 1943.



Fig. 1. Films (A. Immediate. B. Two-hour. C. Twenty-four-hour) showing extent of abscess.

Significant laboratory data on admission were: Total serum proteins 7.5 gm. per cent; hemoglobin 86 per cent; red blood count 4,290,000; white blood count 4,650 with a normal differential; high gastric acidity on analysis; 4+ blood in the stool by the guaiac method.

After a week of preoperative preparation with large amounts of parenteral fluids, vitamins, electrolytes and plasma, dramatic clinical and chemical improvement had occurred. X-ray studies showed a free fistulous opening arising from the first portion of the duodenum and communicating with a bilateral subphrenic abscess, into which barium flowed easily and from which it could be readily removed by lavage.

On Nov. 31, under continuous spinal anesthesia, an exploratory laparotomy was done and an extra-serous exposure of the large abscess cavity obtained. The gastrocolic omentum was adherent to the anterior abdominal wall from the hepatic to the sigmoid flexure, sealing the upper abdomen off from the general peritoneal cavity at about the level of the umbilicus. A large amount of gas and foul smelling liquid was present above this line. This liquid was later found on culture to contain gram-negative bacilli. The liver had dropped well away from the ribs, the space anterior to it being filled with air. The same circumstances applied to the spleen and stomach. The under surface of the liver was fused to the stomach by rather friable, but abundant, pink granulation. Well to the right of the mid-line, near the bottom of the pocket, a somewhat tortuous sinus tract entered this granulating tissue and eventually led into the ulcer. All the edematous tissue and scar were removed to expose the perforation in the anterior wall of the first portion of the duodenum, and the opening, which was about 3.5 cm. in its long diameter, was closed trans-

versely with a Connell type of continuous catgut suture reinforced with a single layer of interrupted fine black silk mattress stitches. The contents of the cavity were removed by suction and it was flushed with saline until clean. After the foul and turbid fluid had been removed, it could be easily demonstrated that the lateral abdominal walls on each side formed the boundary of the cavity. An induration could be palpated in the lesser omental sac. It was estimated that the capacity of the abscess was well over 4,000 c.c. Four grams of sulfanilamide were placed in the abdomen. A cigarette drain was brought out from the most dependent portion through a stab wound posteriorly on the right side and the wound was closed with silver wire, silk sutures being used for the skin.

Although during the first postoperative week the patient's temperature on two occasions was as high as 103° rectally, the vital signs were normal thereafter. A moderate amount of foul smelling, purulent material was discharged from the posterior drain wound for some time and a sinus from the left subphrenic space drained through the abdominal wall. These subsequently closed. A small left pleural effusion appearing around the thirty-second postoperative day cleared spontaneously, without producing symptoms, by the fiftieth postoperative day. Fluids by mouth were tolerated on the second day but were supplemented by daily parenteral administration of glucose, saline, vitamins, and plasma for a week, and thereafter by blood or plasma transfusions as indicated. The patient continued to improve on an ulcer diet and was out of bed in three weeks. On discharge from the hospital March 4, his weight was 136 pounds and the total serum proteins were 5.9 gm. per cent.

The patient was seen again in clinic May 28, 1943, when he was symptom-free. He stated that he felt

better than he had for years. The abdominal wound was well healed without evidence of hernia and the sinus tracts had remained closed. The weight was 143 pounds, a gain of 43 pounds over that recorded on admission.

**X-Ray Findings:** Preoperative fluoroscopic and roentgenographic observations were of interest. Chest studies were not remarkable. Fluoroscopic examination of the abdomen showed an increased translucency over the entire upper abdomen which was especially noticeable in the subdiaphragmatic and superior lateral abdominal areas. The esophageal pattern was normal. Gastric motility was over-

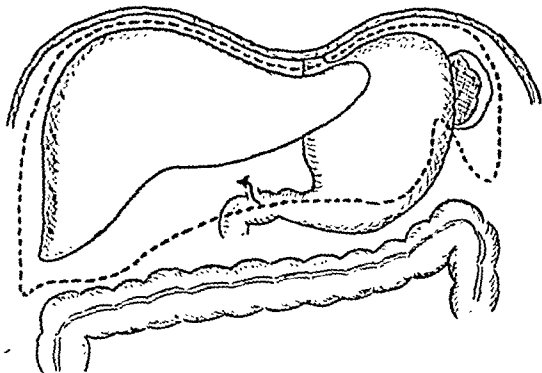


Fig. 2. Diagram showing site of perforation, indicated by arrow. The abscess is outlined by the broken line.

prompt and the contrast medium passed immediately and directly through a defect in the duodenum into a large upper abdominal cavity. Films (Fig. 1) showed this cavity to extend from the diaphragm downward to the level of the 4th lumbar vertebra in its most dependent (right) aspect and laterally to the abdominal wall on either side. Both the liver and spleen were well outlined. The cavity contained barium mixture, other fluids, and air, the level of which was seen to shift in various positions. Serial films showed an irritation pattern in the small intestines. The abscess cavity, after gastric lavage, was almost entirely cleared of the barium fluid mixture, indicating a free fistulous tract at the site of perforation. A diagrammatic sketch (Fig. 2) is included to clarify the films and better demonstrate the operative findings.

Examination on May 28, 1943, revealed no evidence of the previously reported subphrenic abscess cavity. The duodenal bulb was deformed but presented an adequate clearance.

#### SUMMARY

A case is reported in which the rupture of a long standing duodenal ulcer gave rise to a total subphrenic abscess. At operation, an infected cavity was found, involving the entire upper third of the abdomen,

from diaphragm to transverse colon, and from lateral wall to lateral wall. The entire liver, stomach, and spleen were included in the cavity, whose total capacity probably exceeded 4,000 c.c. X-ray films clearly demonstrated the extent of the lesion, and closure of the fistula, with drainage, resulted in clinical cure.

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#### REFERENCES

1. OCHSNER, ALTON AND GRAVES, AMOS M.: Subphrenic Abscess: Analysis of 3,372 Collected and Personal Cases. *Ann. Surg.* 98: 961-990, December 1933.
2. FAXON, H. H.: Logical Approach to Subphrenic Abscess. *Am. J. Surg.* 54: 114-126, October 1941.
3. GOLDING, HARRY, AND DELARIO, A. J.: Left Subphrenic Abscess. *Radiology* 36: 61-71, January 1941.
4. OSBORNE, CARLOS: Roentgen Contribution in Rare Case of Gastroduodenal Perforation. *Rev. brasil. de cir.* 10: 325-341, August 1941.
5. BARNARD, H. L.: An Address on Surgical Aspects of Subphrenic Abscess. *Brit. M. J.* 1: 371, 429, 1908.

### Two Unusual Cases of Urinary Tract Calculi<sup>1</sup>

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Philadelphia, Penna.

Two striking cases of urinary tract calculi were recently examined in the Radiologic Clinic of The Hospital of the University of Pennsylvania. In each patient a survey film of the abdomen showed multiple smooth, round shadows arranged in groups, but in neither the position nor of the configuration usually attributable to urinary tract calculi. In one instance intravenous urography was sufficient to establish the diagnosis; in the other, intravenous urography and retrograde pyelography were required.

CASE I: I. R., white male, aged 23, was first seen in the Gastro-intestinal Clinic for symptoms suggestive of gallbladder disease. For two years he had complained of epigastric fullness, belching, and pain across the upper abdomen occurring about one hour after meals and persisting for several hours. The pain was not relieved by food. There was no nausea or vomiting; no changes had been

<sup>1</sup> From the Radiologic Clinic of The Hospital of the University of Pennsylvania. Accepted for publication in July 1943.





Figs. 1 and 2. Case I: Multiple urinary calculi (calcium oxalate) in the left kidney in a young man, aged 23. In Figure 1 (left) the right kidney shadow is seen readily; the left shadow is difficult to outline clearly. The calculi are distributed largely in the lower pole, but there are shadows in the middle and upper portions of the kidney. In the lateral view, the shadows of the calculi were anterior to the bodies of the vertebrae. In Figure 2 the mass on the left side is seen to be displacing the colon anteriorly and toward the mid-line. The urinary calculi have changed their position from that seen in Figure 1. In some respects the shadows of the calculi simulate those produced by phleboliths in a large hemangioma of the omentum. One can see soft-tissue shadows that are smaller and do not look like those of a huge kidney.



Fig. 3. A Urogram of patient shown in Figure 1. On the left side the large kidney is outlined by arrows. B. Retrograde pyelogram of same patient. The ureter is displaced toward the mid-line. The pyelographic medium is all in one mass, as frequently occurs in large hydronephrotic kidneys. The position of the calculi has changed again. The patient had a nephrectomy and the large hydronephrosis was found to be due to a congenital vessel at the ureteropelvic junction.

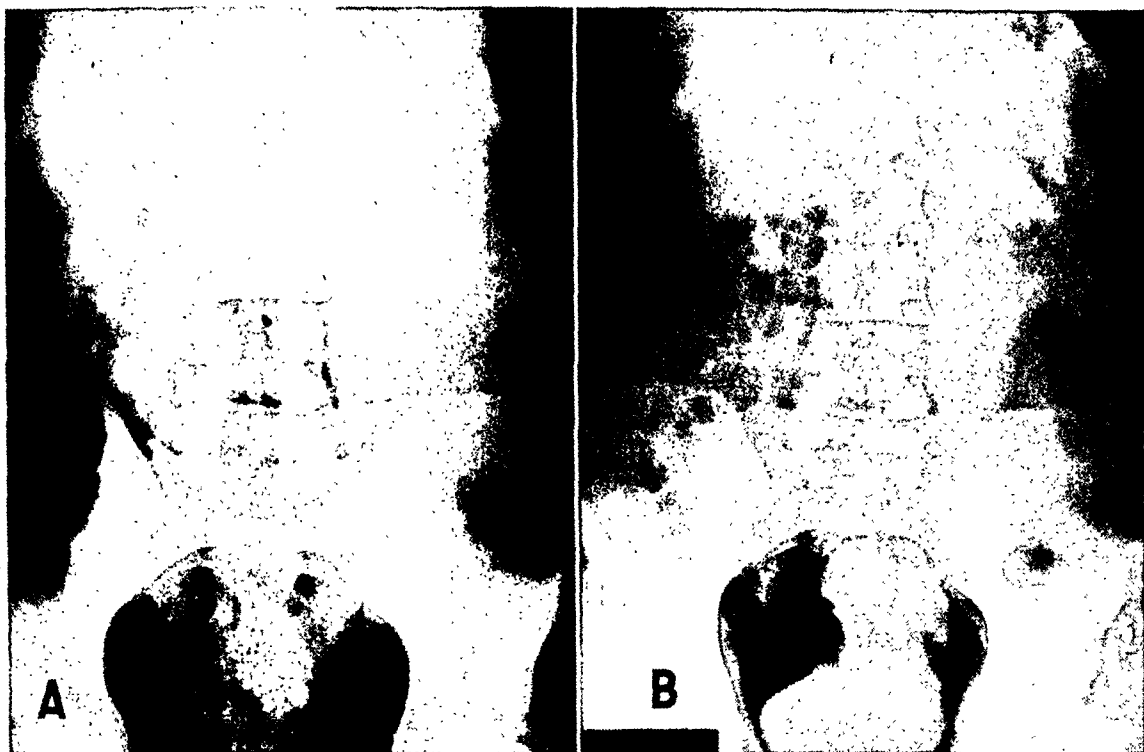


Fig. 4. Case II: Calculi in the lower end of the left ureter in a male, aged 28.

A. Both kidney shadows are seen and appear normal. A group of shadows is seen in the mid-line of the pelvis outside the usual bladder or ureteral position. The diagnosis at this time was uncertain, although the history suggested urinary tract dysfunction. This patient was studied shortly after the one illustrated in Figure 1 and the character of the shadows in the two patients was similar. These calculi contained calcium oxalate, calcium carbonate, and calcium phosphate.

B. Urogram. The clearance of diodrast on the right was within normal limits, but on the left side the clearance was so poor that it was necessary to prolong the examination. At an hour and a half one can see that the calices are slightly dilated and the left ureter is tremendously dilated and redundant. The calculi were in one of the redundant loops that was situated practically in the mid-line.

observed in the stools, and there were no complaints referable to the urinary tract, such as frequency, dysuria, or hematuria. Except for childhood diseases the patient had never been ill so far as he or his parents could recollect.

Physical examination was completely negative, and the patient appeared to be in excellent health. Hemoglobin 90 per cent, white blood count 5,900, blood urea nitrogen 12 mg. per 100 c.c., normal P.S.P. test. Routine chemical and microscopic urinalysis showed normal findings.

The patient was first referred to the Department of Radiology for cholecystography. This revealed a functioning gallbladder. On one of the roentgenograms, a 14 X 17-inch film, a large mass was observed occupying the left lower quadrant within which there were abnormal areas of density (Fig. 1). Roentgenograms in various positions demonstrated the mobile character of these densities. Because the symptoms were essentially gastro-intestinal and since no mass could be palpated in the left lower abdominal quadrant, a barium meal examination and subsequently a barium enema study were performed. These were negative for intrinsic disease but showed displacement of the small in-

testine and descending and sigmoid colon to the right and anteriorly (Fig. 2). Intravenous urography demonstrated absence of kidney function on the left side (Fig. 3A). A retrograde study finally revealed a huge hydronephrotic sac in this region containing multiple calculi (Fig. 3B). At operation the roentgen diagnosis was confirmed and following nephrectomy and a transient bronchopneumonia the patient has been symptomless and well.

Examination of the gross surgical specimen revealed hydronephrosis, nephrolithiasis, and a congenital polar vessel causing constriction of the pelvis at the ureteropelvic junction. The stones were composed of calcium oxalate.

The pathological process had evidently been present for a long time in this case, which serves to emphasize how relatively silently a urinary tract lesion may develop to considerable proportions before giving rise to symptoms. That urinary tract disease is often heralded by gastro-intestinal complaints is a fact which frequently



Fig. 5. Case II: Pyelogram. The position of the catheter illustrates the extent of the redundant ureter.

is overlooked, particularly when the routine blood and urine studies are negative.

CASE II: J. N., white male, aged 28, was admitted with symptoms of four months' duration, consisting of intermittent left loin pain, radiating down the groin and into the scrotum, and pain over the left hip relieved by rest. Three years previously he had experienced a short episode of hematuria which had been neglected. There was now no hematuria, dysuria, or frequency. The remainder of the body systems were symptomless.

Physical examination showed a healthy young man with no apparent abnormalities. There was no palpable abdominal mass and no loin tenderness. The routine blood count was normal, and urinalysis showed clear urine with a pH of 7.0, sp. grav. 1.005, and only a few epithelial cells seen microscopically. The blood pressure was 130/90. Temperature, pulse, and respirations were normal.

A survey film of the abdomen studied preparatory to urography revealed multiple round, grouped opacities in the mid-line overlying the sacrum (Fig. 4A). Intravenous urography demonstrated a left obstructive uropathy, the point of obstruction by multiple calculi being at the distal third of the left ureter (Fig. 4B). That the calculi were in the ureter was proved by ureteral catheterization and retrograde pyelography (Fig. 5). Ureterotomy was performed and 72 stones were removed. A rubber catheter was placed in the ureter for drainage. Subsequently, ureteral dilatation was performed, and at the time of writing the patient's condition is satisfactory. The calculi were composed of calcium oxalate, calcium carbonate, and calcium phosphate.

These two cases are reported for the following reasons:

1. The roentgen pictures of the calculi are quite similar and differ from the shadows of urinary calculi seen in many instances even though in one case there was obstruction at the ureteropelvic junction and in the other the obstruction was in the lower end of the ureter.
2. Difficulty in diagnosis existed in Case I because of the disturbed function and the absence of symptoms referable to the urinary tract.



# EDITORIAL

Howard P. Doub, M.D., Editor

John D. Camp, M.D., Associate Editor

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Announcing a Joint Meeting  
of  
The Radiological Society of North America  
and  
The American Roentgen Ray Society  
at  
The Palmer House, Chicago, Ill.  
September 24 to 29, 1944

The officers and members of the Program Committees of the Radiological Society of North America and the American Roentgen Ray Society, at a meeting held in Chicago, February 12, 1944, decided that the interests of all radiologists on the North American continent could best be served by conducting a joint meeting in 1944.

It appears obvious that, through such a meeting, radiologists in military and civilian practice could obtain much valuable information regarding the recent technical and scientific advances in radiology. The dissemination of such knowledge is recognized as a valuable contribution to the successful prosecution of our military activities.

Because of its central location, Chicago was selected as the most desirable city for the meeting. Prompt action was necessary in order to obtain adequate hotel facilities, and we have been assured that sufficient rooms will be made available in the Palmer House for those who wish to attend.

It is not too early to make your plans for the meeting, and you are invited to submit contributions to the scientific program and exhibits as soon as possible.

ELDWIN R. WITWER, *President*  
*Radiological Society of North America*  
LYELL C. KINNEY, *President-Elect*  
*American Roentgen Ray Society*

# Presidential Address

Twenty-Ninth Annual Meeting of the Radiological Society of North America<sup>1</sup>

The year during which I have served as your President has been a war year. We as a society felt it our duty to cancel our scientific sessions and accept the many papers which were scheduled for presentation as "read by title." During war periods we are all thrown out of our routine; time is precious; momentous happenings are occurring; history is made more rapidly. But it is, as well, a time when we can look back on the past in a new light and see whether what we were doing in the relatively calm period before the war was leading us in the right direction.

Some years ago Sir Clifford Allbutt studied the history of medicine to see what he could learn from the changing relations of medicine (internal medicine) and surgery that should point the way for the future relationship of those two major divisions of medical practice. While reading his address on that subject, I saw some aspects that should help us as radiologists to adjust ourselves properly in the general scheme of things medical.

In the days of Hippocrates there was no division into medicine and surgery. The field of medicine covered all. Surgery was but a method of treatment and a means of finding out what was taking place on the inside, where the eye could not penetrate. In that period the knowledge of disease advanced rapidly. The doctor did not hesitate to use surgery or any other method of treatment that would benefit the patient or increase the understanding of the medical problem.

Down through the years that followed, physicians gradually lost contact with surgery because they scorned the practical art. There came a time, in fact, in the Middle Ages, when any actual contact with the patient was considered demeaning to the medical man. Losing contact

with reality, medicine wandered into fields of metaphysics. Sitting in their offices and halls of learning, physicians received reports of their patients and philosophized about them. At this period, medicine was sterile.

There was a period in the Paris school when the surgeons emulated the physicians. They also met in their academic halls and learnedly discussed what some one else should do. The actual surgery was left to the barber-surgeons, the stone-cutters, and the herniotomists. Academic surgery became as sterile as medicine. But "surgery" did not become a lost art because the technicians—barber surgeons, stone-cutters, and herniotomists—kept it alive, and from their ranks rose men to re-establish it as a science.

I will not take the time to discuss the various ways by which medicine and surgery gradually came together again—to such extent as they have—because the lesson for us lies in the period when the loss of contact with reality led to such sterility.

There is now and has been for some years a marked tendency for radiologists to sit in their offices and "read films" or discuss treatment. In the diagnostic division contact with the patient is often entirely absent, and in the therapy division it is frequently cursory at best. We should be aware of the fact that to the patient, the technician who takes the films or is seen daily in the therapy room is more important than the radiologist in the distant office.

Technicians who have seen the patient and the films can sometimes give a more shrewd opinion as to the condition present than can the radiologist in his easy chair. They see the patient as well as the films, whereas we often see only the films. It is all too true that a good look at the pa-

<sup>1</sup> Chicago, Ill., Dec. 1-2, 1943.

tient can often lead to an explanation of shadows which hours spent in study of the film alone will not reveal.

In the field of radiation therapy it has become too prevalent a practice for the radiologist to read the clinician's notes and then write out a chart directing how the patient is to be treated: "200 roentgens per day to such and such fields to a total of 2,000 roentgens per field." The patient is either not seen at all or is only superficially examined on the first day and not seen again. It doesn't take a technician long, with daily observation of the patient, to feel that she knows better than the radiologist what the treatment should be. Nor does it take our medical colleagues long to realize that they can write out routine orders from dosage tables, directing how many roentgens per day should be given to *their* patients—and have the technician administer the treatments. If that is all there is to x-ray therapy we have no reason for existence.

Is history going to repeat itself? Are we losing contact with reality as did the doctors of the Middle Ages? Are we coming to the metaphysical and philosophizing stage of radiology? Are we turning over to the technicians the practical side of our specialty to such an extent that they will eventually displace us as the barber-surgeons did the academic surgeons? How are we to prevent history repeating itself?

The first step is for each of us to return to the role of physician. By this I mean that we should have contact with those patients whose diseases we diagnose or treat. It cannot, of course, be the thorough contact of the referring physician; otherwise there is no need of both a physician and a radiologist. But it can be such a contact that the patient knows that there is a physician involved in taking the films and in making a diagnosis by x-ray, and that we, by seeing the lesion as well as the film, can make a more complete diagnosis for the referring doctor and establish ourselves in his eyes as consultants rather than film-readers. In the realm of therapy, I

hope that it means that we are to take full care of the patients referred to us for treatment. We do not find many surgeons allowing the physician to take care of the patient while he is being treated surgically. Neither should we find radiologists allowing physicians or surgeons to take care of their patients while these are receiving x-ray therapy.

A common practice, interfering greatly with the results of x-ray therapy, is that of the referring physician or surgeon failing to give up a case sufficiently for the radiation therapist to handle it as he deems fit. I know there are centers of which this is not true, but if you visit many radiologists' offices, you will find all too often that the radiologist is to a large extent under the direction of the referring doctor not only as to the general management of the patient but also as to where and how much radiation should be given. Proper radiation therapy includes the proper management of the patient between treatments as well as the proper administration of the radiation. Some of us lack the courage to tell the surgeon or the physician that we should manage the case, that we must be in charge if proper results are to be obtained.

Another need is for us to realize that radiology is not God's gift to us alone. A knowledge of radiology, as of any other medical specialty, can be acquired by anyone in the field of medicine who cares to spend the necessary time in study. There are some very good radiologists among surgeons, as there are some good surgeons among radiologists, and there is no reason why we should attempt to set up a guild of radiologists that refuses to allow anyone else to look at a film or to allow any of its members to do anything besides radiology. It is true that each one of us is limited in his abilities. In practice our limitation should be on the basis of personal ability and not artificial division. Modern medicine has inherited from medieval medicine the custom of assigning certain diseases to physicians and others to surgeons. Even in com-



(Underwood & Underwood, Washington, D. C.)  
 WRIGHT CLARKSON, M.D.  
 1889-1943

professional care and attention given his patients, the financial status of the individual played not the slightest role. His ability as an organizer and leader contributed much to medicine as a whole, and particularly to the profession in his state and community. His interest in the control of cancer was one of the most important and stimulating influences toward the development of an effective organization for that purpose in Virginia. In 1924, he opened in his office a free cancer clinic, the first of its kind in the state. As an outgrowth of that, the Virginia Cancer Foundation was organized in 1934, with Doctor Clarkson as its first Director. His enthusiasm and counsel will be greatly missed in the future work of this organization, which is doing a great work throughout the state.

Doctor Clarkson belonged to many medical societies, a number of which he served faithfully and over long periods of time as a member of various committees. He was the founder of the Virginia Radiological Society and its President at the time of his death. He was a former Councillor and Chairman of the Legislative Committee of the Medical Society of Virginia, a member of the House of Delegates of the American Medical Association, a member of the Radiological Society of North America and American Roentgen Ray Society, a fellow of the

American College of Radiology, and a diplomate of the American Board of Radiology. His contributions to medical literature were numerous.

Doctor Clarkson's loyal devotion to his profession and colleagues gained the respect and admiration of all who knew him. Although burdened with a large practice, he could always take time to help solve the problems of his friends and colleagues when called upon. He found time, also, to devote to church and civic duties.

A recent letter received from one of Doctor Clarkson's close friends, Dr. J. Shelton Horsley, of Richmond, Va., pays tribute to him and sums up his outstanding characteristics and qualities as follows:

"Wright Clarkson was one of the finest and most loyal men I have ever known. He was devoted to the medical profession and to his specialty, and was one of the leading citizens of Petersburg. He was the type of man who can be depended upon under all conditions and circumstances.

"His death was a great loss not only to his City, but to the State and also to the Nation."

CLAYTON W. ELEY, M.D.

JAMES BOYD MASON, M.D.

1874-1943

Dr. James Boyd Mason of London, Ky., died on Dec. 2, 1943. Doctor Mason was born in 1874. He was graduated in 1894 from the University of Louisville (Kentucky) and did postgraduate work at the Chicago Clinical School. His practice of medicine lacked only a few months of reaching the half-century mark. He was commissioned Major in World War I and served as Roentgenologist both in the states and abroad. He was a member of the Board of Examiners for Radiologic Technicians for Kentucky and a member of the Radiological Society of North America.

## Books Received

Books received are acknowledged under this heading, and such notice may be regarded as recognition of the courtesy of the sender. Reviews will be published in the interest of our readers and as space permits.

THE MODERN MANAGEMENT OF COLITIS. By J. ARNOLD BARGEN, M.D., M.S., F.A.C.P., Chief of the Section on Intestinal Diseases, Division of Medicine, Mayo Clinic; Associate Professor of Medicine, Mayo Foundation, Rochester, Minnesota; Secretary, American Gastroenterological Association; Vice-Chairman, Section on Gastroenterology and Proctology, American Medical Association. A volume of 322 pages, with 148 figures. Published by Charles C Thomas, Springfield, Ill. Price \$7.00.

## Book Reviews

**MEDICAL RADIOGRAPHIC TECHNIC.** Prepared by Members of The Technical Service Department of General Electric X-Ray Corporation under the editorial supervision of GLENN W. FILES, Director. A volume of 364 pages, illustrated with 381 original figures. Published by Charles C Thomas, Springfield, Ill. Price \$6.00 postpaid.

This volume, prepared by the Technical Service Department of the General Electric X-Ray Corporation, was originally projected as a co-ordinated plan of instruction for classes in radiographic technic. According to the Preface, it is "a book written by technicians for technicians, an accumulation of material based upon facts now available which have proven to be an aid in producing a 'better end result' and reasons why." Actually it can be recommended as a reference book of value to all who are interested in the underlying factors necessary for the production of good roentgenograms. It brings together many facts which formerly could not be found in a single volume, and thus fills a long-felt need.

The first chapters are devoted to a study of the basic electrical factors involved in producing x-rays, together with a description of the various types of circuits and machines, including an adequate description of the hot cathode tube, which has played so great a part in modern roentgenology. Several chapters are devoted to factors affecting the quality of the radiograph, and these are well worth reading. Chapters are also included on processing films, stereoscopy, planigraphy, soft-tissue radiography, and anatomy.

The chapter on positioning and technic is of special interest for its many unique composite photographs showing the position of the area being examined and the angulation of the central ray. A suggested technic for each view is given, together with variations depending upon differences in the thickness of the part, screens, etc. The chapter on dental technic is similarly arranged.

The text is amply illustrated with photographs and drawings. A good index enables the reader to

find without delay the object of his search. The volume is attractively bound and a good quality of paper is used.

**THE 1943 YEAR BOOK OF RADIOLOGY.** Diagnosis edited by CHARLES A. WATERS, M.D., Associate in Roentgenology, Johns Hopkins University; Assistant Visiting Roentgenologist, Johns Hopkins Hospital, and WHITMER B. FIROR, M.D., Assistant in Roentgenology, Johns Hopkins University; Assistant in Roentgenology, Johns Hopkins Hospital. Therapeutics edited by IRA I. KAPLAN, B.Sc., M.D., Director, Radiation Therapy Department, Bellevue Hospital, New York City; Associate Radiologist, Lenox Hill Hospital, New York City; Clinical Professor of Surgery, New York University Medical College. A volume of 456 pages and 378 illustrations. Published by The Year Book Publishers, Inc., Chicago, Ill., 1943. Price \$5.00.

A summary of the current radiological literature is presented in abstract form in this new issue of the *Year Book of Radiology*.

The diagnostic section comprises 272 pages out of a total of 456. The material is classified on an anatomical basis, with the addition of special sections on Technic and Teaching and Principles of Practice, which adds greatly to the convenience of reviewing any given subject. The abstracts are competently prepared and in many instances supply all the essential information. Illustrations add to their value.

The section on radiotherapeutics maintains the standard set in the diagnostic section. It includes an extensive introduction by the Editor, who calls attention to significant articles on cancer and radiotherapeutics in general. This is followed by sections on radiation biology, radiation physics, and the application of roentgen rays and radium in various parts of the body.

The volume is adequately indexed so that its contents are readily available. Like its predecessors, it is of definite value for quick reference to the world's radiologic literature.



# RADIOLOGICAL SOCIETIES OF NORTH AMERICA

**Editor's Note.**—Will secretaries of societies please cooperate by sending information to Howard P. Doub, M.D., Editor, Henry Ford Hospital, Detroit 2, Mich.

## UNITED STATES

**Radiological Society of North America.**—*Secretary*, D. S. Childs, M.D., 607 Medical Arts Building, Syracuse, N. Y.

**American Roentgen Ray Society.**—*Secretary*, Harold Dabney Kerr, M.D., Iowa City, Iowa.

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**Chicago Roentgen Society.**—*Secretary*, Warren W. Furey, M.D., 6844 S. Oglesby Ave. Meets at the Palmer House, second Thursday of October, November, January, February, March, and April.

**Illinois Radiological Society.**—*Secretary-Treasurer*, William DeHollander, M.D., St. Johns' Hospital, Springfield. Meetings quarterly by announcement.

**Illinois State Medical Society, Section on Radiology.**—*Secretary*, Fay H. Squire, M.D., 1753 W. Congress St., Chicago.

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**The Indiana Roentgen Society.**—*Secretary-Treasurer*, Harold C. Ochsner, M.D., Methodist Hospital, Indianapolis. Annual meeting in May.

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**The Iowa X-ray Club.**—Holds luncheon and business meeting during annual session of Iowa State Medical Society.

## KENTUCKY

**Kentucky Radiological Society.**—*Secretary-Treasurer*, Sydney E. Johnson, M.D., Louisville City Hospital, Louisville. Meeting annually in Louisville, third Saturday afternoon in April.

## LOUISIANA

**Louisiana Radiological Society.**—*Secretary-Treasurer*, Johnson R. Anderson, M.D., North Louisiana Sanitarium, Shreveport. Meets annually at same time as State Medical Society.

**Shreveport Radiological Club.**—*Secretary-Treasurer*, R. W. Cooper, 940 Margaret Place. Meetings monthly on the second Wednesday, at the offices of the various members.

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**Baltimore City Medical Society, Radiological Section.**—*Secretary*, Walter L. Kilby, M.D., 101 W. Read St. Meetings are held the third Tuesday of each month.

## MICHIGAN

**Detroit X-ray and Radium Society.**—*Secretary-Treasurer*, E. R. Witwer, M.D., Harper Hospital, Detroit. Meetings first Thursday of each month from October to May, inclusive, at Wayne County Medical Society club rooms, 4421 Woodward Ave., Detroit.

**Michigan Association of Roentgenologists.**—*Secretary-Treasurer*, E. M. Shebesta, M.D., 1429 David Whitney Bldg., Detroit. Meetings quarterly by announcement.

## MINNESOTA

**Minnesota Radiological Society.**—*Secretary*, John P. Medelman, M.D., 572 Lowry Medical Arts Bldg., St. Paul. Meetings quarterly.

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**The St. Louis Society of Radiologists.**—*Secretary*, Paul C. Schnoebelen, M.D., 462 N. Taylor Ave. Meets on fourth Wednesday of each month except June, July, August, and September, at a place designated by the president.

## NEBRASKA

**Nebraska Radiological Society.**—*Secretary*, F. L. Simonds, M.D., 1216 Medical Arts Bldg., Omaha. Meetings third Wednesday of each month at 6 P.M. in either Omaha or Lincoln.

## NEW ENGLAND

**New England Roentgen Ray Society** (Maine, New Hampshire, Vermont, Massachusetts, and Rhode Island).—*Secretary*, Hugh F. Hare, M.D., Lahey Clinic, Boston, Mass. Meets monthly on third Friday at Boston Medical Library.

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*Radiological Society of New Jersey.*—*Secretary*, H. J. Perlberg, M.D., Trust Co. of New Jersey Bldg., Jersey City. Meetings at Atlantic City at time of State Medical Society and midwinter in Newark as called by president.

## NEW YORK

*Associated Radiologists of New York, Inc.*—*Secretary*, William J. Francis, M.D., 210 Fifth Ave., New York City. Regular meetings the first Monday evening of the month in March, May, October, and December.

*Brooklyn Roentgen Ray Society.*—*Secretary-Treasurer*, Leo Harrington, M.D., 880 Ocean Ave. Meetings held the fourth Tuesday of every month, October to April.

*Buffalo Radiological Society.*—*Secretary-Treasurer*, Joseph S. Gianfranceschi, M.D., 610 Niagara St. Meetings second Monday evening each month, October to May, inclusive.

*Central New York Roentgen Ray Society.*—*Secretary-Treasurer*, Carlton F. Potter, M.D., 425 Waverly Ave., Syracuse. Meetings are held in January, May, and October, as called by Executive Committee.

*Long Island Radiological Society.*—*Secretary*, Marcus Wiener, M.D., 1430 48th St., Brooklyn. Meetings fourth Thursday evening each month at Kings County Medical Bldg.

*New York Roentgen Society.*—*Secretary*, Haig H. Kasabach, Presbyterian Hospital, New York, N. Y.

*Rochester Roentgen-ray Society.*—*Secretary*, S. C. Davidson, M.D., 277 Alexander St. Meetings at convenience of committee.

## NORTH CAROLINA

*Radiological Society of North Carolina.*—*Secretary-Treasurer*, Major I. Fleming, M.D., 404 Falls Road, Rocky Mount. Meeting with State meeting in May, and meeting in October.

## NORTH DAKOTA

*North Dakota Radiological Society.*—*Secretary*, L. A. Nash, M.D., St. John's Hospital, Fargo. Meetings by announcement.

## OHIO

*Ohio Radiological Society.*—*Secretary*, J. E. McCarthy, M.D., 707 Race St., Cincinnati. The next meeting will be held at the time and place of the annual meeting of the Ohio State Medical Association.

*Cleveland Radiological Society.*—*Secretary-Treasurer*, Don D. Brannan, M.D., 11311 Shaker Blvd., Cleveland 4. Meetings at 6:30 P.M. on fourth Monday of each month from October to April, inclusive.

*Radiological Society of the Academy of Medicine* (Cincinnati Roentgenologists).—*Secretary-Treasurer*, Samuel Brown, M.D., 707 Race St. Meetings held third Tuesday of each month.

## PENNSYLVANIA

*Pennsylvania Radiological Society.*—*Secretary-Treasurer*, L. E. Wurster, M.D., 416 Pine St., Williamsport. The Society meets annually.

*The Philadelphia Roentgen Ray Society.*—*Secretary*, Robert P. Barden, M.D., 3400 Spruce St., Philadelphia. Meetings held first Thursday of each month at 8:15 P.M., from October to May, in Thomson Hall, College of Physicians, 21 S. 22nd St., Philadelphia.

*The Pittsburgh Roentgen Society.*—*Secretary-Treasurer*, Reuben G. Alley, M.D., 4800 Friendship Ave., Pittsburgh, Pa. Meetings are held on the second Wednesday of each month at 4:30 P.M., from October to June, at the Pittsburgh Academy of Medicine, 322 N. Craig St.

## ROCKY MOUNTAIN STATES

*Rocky Mountain Radiological Society* (North Dakota, South Dakota, Nebraska, Kansas, Texas, Wyoming, Montana, Colorado, Idaho, Utah, New Mexico).—*Secretary*, A. M. Popma, M.D., 220 North First St., Boise, Idaho.

## SOUTH CAROLINA

*South Carolina X-ray Society.*—*Secretary-Treasurer*, Robert B. Taft, M.D., 103 Rutledge Ave., Charleston. Meeting in Charleston on first Thursday in November, also at time and place of South Carolina State Medical Association.

## TENNESSEE

*Memphis Roentgen Club.*—Chairmanship rotates monthly in alphabetical order. Meetings second Tuesday of each month at University Center.

*Tennessee Radiological Society.*—*Secretary-Treasurer*, J. Marsh Frère, M.D., 707 Walnut St., Chattanooga. Meeting annually with State Medical Society in April.

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*Texas Radiological Society.*—*Secretary-Treasurer*, Herman Klapproth M.D., Sherman.

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## WISCONSIN

*Milwaukee Roentgen Ray Society.*—*Secretary-Treasurer*, C. A. H. Fortier, M.D., 231 W. Wisconsin Ave., Milwaukee. Meets monthly on second Monday at the University Club.

*Radiological Section of the Wisconsin State Medical Society.*—*Secretary*, Russell F. Wilson, M.D., Beloit Municipal Hospital, Beloit. Two-day annual meeting in May and one day in connection with annual meeting of State Medical Society, in September.

*University of Wisconsin Radiological Conference.*—*Secretary*, E. A. Pohle, M.D., 1300 University Ave., Madison, Wis. Meets every Thursday from 4 to 5 P.M., Room 301, Service Memorial Institute.

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*La Société Canadienne-Française d'Électrologie et de Radiologie Médicales.*—*General Secretary*, Origène Dufresne, M.D., Institut du Radium, Montreal. Meetings are held the third Saturday of each month, generally at the Radium Institute, 4120 East Ontario Street, Montreal; sometimes, at homes of members.

## CUBA

*Sociedad de Radiología y Fisioterapia de Cuba.*—Offices in Hospital Mercedes, Havana. Meetings are held monthly.

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## THE HEAD AND NECK

**Notes on the Radiography of Head Injuries.** E. W. Frecker. *M. J. Australia* 2: 144-146, Aug. 21, 1943.

The author discusses both plain radiography of the skull and pneumoencephalography.

Plain radiography for demonstration of skull fractures is a routine procedure in all cases of head injury, for while the fracture itself is of secondary importance, determination of its extent and nature may furnish valuable information concerning a possible associated brain injury. Thus, a fracture in the region of the meningeal artery causes one to anticipate meningeal hemorrhage, while fracture in the region of the frontal sinuses or mastoids points to the possibility of a traumatic arocele either immediately or weeks later.

In acute injuries two lateral views and one antero-posterior view are considered adequate for a primary examination, and even these should be postponed until recovery from shock. A postero-anterior view should never be attempted in the case of a confused and restless patient. Examinations with a portable machine are not satisfactory and should be repeated with standard apparatus if possible. Stereoroentgenograms are used only in settling particularly difficult problems.

Ordinary fracture lines in the adult skull may remain visible for one or two years, but in children they often disappear in six to eight months.

Pneumoencephalography must be considered in the demonstration of post-traumatic changes. Ventriculography outlines the ventricles and encephalography in addition renders visible the cisterns, the cortical pathways, and almost any part of the subarachnoid space. Deviation of the ventricles from the mid-line may be due to a lesion pushing toward the opposite side or to scar tissue or atrophy pulling toward the affected side. Dilatations of the ventricles suggest obstruction. Meningocerebral scars and localized areas of cortical atrophy may be visualized.

The technic for the introduction of air is necessarily specialized and demands special facilities. The author believes that a trained radiologist should be a part of every neurosurgical clinic so that he may be educated in the complexities of brain pathology and in return give the neuroclinician a greater degree of roentgenological assistance.

DONALD R. LAING, M.D.

**Electrocardiographic Changes During Pneumoencephalography.** Malcolm W. Bick and Bernard S. Epstein. *Am. Heart J.* 26: 200-212, August 1943.

Electrocardiographic examinations were made before, during, and after pneumoencephalography on 12 patients. All tracings showed alterations, which varied in type and degree. These were divided into two categories: those concerned with the pacemaking mechanism and those which presented wave form changes. Both may occur in the same patient. In some cases only slight wave changes appeared when there was a marked pacemaker disturbance; in others the converse was true. In 3 patients the changes were pronounced, in 5 moderate, and in 4 slight.

In 10 cases in the first group there were changes which varied from a slight slowing of the rate to sinus arrhythmia, nodal beats, auriculoventricular dissocia-

tion and interference, wandering pacemaker, and auricular flutter.

In 8 cases in the second group there were slight to marked alterations in the P and T waves and the S-T segments. In 2 cases variations in height and direction of the QRS complexes occurred.

The cardiac changes are caused principally by central vagal stimulation. HENRY K. TAYLOR, M.D.

**Diagnosis of Cervical Metastasis from Squamous Carcinoma of the Mouth and Throat.** C. A. Whitcomb. *Am. J. Roentgenol.* 50: 219-229, August 1943.

The physical diagnosis of small metastases in the cervical lymph nodes is difficult and even a large mass cannot be diagnosed as metastatic with certainty by physical examination until the primary cancer has been found. The metastasis of squamous carcinoma about the mouth appears with rare exception as a gradual enlargement of a single cervical node in a location which is predictable and which is determined by the site of the primary lesion. Since differentiation of inflammatory and metastatic masses is difficult on physical examination alone, microscopic study of a biopsy specimen is recommended in all cases. Only in this way can one be certain of the diagnosis and the result of therapy. Prophylactic treatment for possible cervical metastasis is unnecessary, since in a large percentage of cases of squamous carcinoma arising in or about the mouth this never occurs. L. W. PAUL, M.D.

**Postoperative Parotitis with Radiation Treatment.** Daniel C. Patterson. *Am. J. Surg.* 59: 172-176, February 1943.

Postoperative parotitis is a serious condition and it is most important that it be recognized in its early stage, for a successful result demands early treatment. It differs widely from non-surgical parotitis, or mumps, in the shortness of the incubation period, the tendency to suppuration, and the high mortality. The etiology of the disease is undetermined. It may follow any type of operation whether septic or not. It is usually ushered in with sudden high fever and malaise within a week after operation. The infected gland early shows swelling, and the diagnosis should be easily made. Lugol's solution and sulfonamides have been found of some value in controlling infections of this type, but irradiation has been most effective. The author presents five cases of postoperative parotitis, in which roentgen therapy was employed with excellent results.

## THE CHEST

**Control of Diagnostic Quality in Roentgenograms of the Chest.** Russell H. Morgan. *Am. J. Roentgenol.* 50: 149-161, August 1943.

The production of diagnostically excellent roentgenograms of the chest is primarily dependent upon adequate control of roentgenographic exposure and of the process of developing. In the method most commonly in use today exposure technic is determined by the thickness of the anatomical structure under examination. Intensity, however, is governed also by the absorption characteristics of the tissues, which are not

necessarily reflected in measurements of tissue thickness, and this method of exposure calculation cannot, therefore, be expected to yield consistently uniform results.

A roentgen-ray intensitometer has been devised by the author which seems to overcome the difficulties formerly encountered in determining adequate exposure. The apparatus is similar in basic design to the photographic exposure meter commonly employed in photographic work and includes as essential components a radiation detector (comprising a small fluorescent screen), a phototube, a vacuum tube amplifier, and a second unit including a microammeter and a power supply. When roentgen rays impinge on the radiation detector, the screen fluoresces, and in response to this radiation the phototube conducts a small electric current, the magnitude of which is proportional to the effective intensity of the roentgen radiation. This current is amplified and is then recorded by the microammeter. Thus, meter deflections are proportional to the intensity of the roentgen rays.

The only disadvantage of this type of exposure meter is that two exposures are necessary, one for making the roentgenometric reading and one for exposing the film. This objection has been effectively overcome by the development of a second type of exposure meter, a photoelectric timing mechanism with which roentgenographic exposure is controlled automatically. With this device, films are placed in the cassette changer, suitable kilovoltage and milliamperage settings are chosen, and the exposure switch of the roentgen machine is closed. When the proper quantity of radiation has been delivered to the film, the photoelectric timing mechanism breaks the roentgen-ray circuit, and the exposure is terminated automatically. At the present time the multiplier-type phototubes necessary for this operation are not generally available and they may not be until after the war is over.

In addition to proper control of roentgenographic exposure, it is also essential that the developing process be done correctly. A strict adherence to a time-temperature method of development is essential.

L. W. PAUL, M.D.

**Foreign Bodies in the Air Passages of Children.** P. M. Frederick and J. G. Verberkmoes. *West. J. Surg.* 51: 325-329, August 1943.

Thirty cases of foreign body aspiration in children seen during a ten-year period are reviewed, and emphasis is placed on the importance of early diagnosis and treatment in the reduction of morbidity and prevention of mortality.

The age of the youngest patient was seven weeks and of the oldest twelve years. In 23 cases the foreign body consisted in vegetal food matter, the peanut being the greatest offender. Six patients were treated for asthma, pneumonia, and bronchitis before the correct diagnosis was made and therapy instituted. Empyema occurred in two cases where a peanut and a tack remained in a bronchus for one and two months, respectively. Multiple bronchoscopies were needed to drain a lung abscess and remove particles of fruit cake aspirated six weeks previously. Tracheotomy was performed in four instances of edema following bronchoscopy. One death is reported from circulatory failure despite prompt removal of a peanut fragment after admission to the hospital eight hours following the accident and the use of intracardiac stimulants combined with artificial respiration.

"In establishing a diagnosis, next in importance to a positive history are the physical signs." In the variable symptom-free period that usually follows aspiration of a foreign body, an asthmatic wheeze at the end of forced expiration can be detected by placing the ear or stethoscope bell to the mouth. After symptoms have developed, the following three signs are most common: (1) unilateral limitation of expansion of the affected side; (2) hyperresonance to percussion (obstructive emphysema); (3) diminished or absent breath sounds.

Routine roentgen examination should include fluoroscopic studies as well as films made in expiration and inspiration. Limitation of diaphragmatic excursion may be elicited on the affected side as well as evidence of obstructive emphysema and, later, signs of atelectasis. Vegetal foreign matter is rarely radiopaque.

There is no contraindication to bronchoscopy in suspected foreign body aspiration. The use of anesthesia is controversial. Nitrous oxide and ether were used with caution in 23 of the cases in the authors' series.

LESTER M. J. FREEDMAN, M.D.

**Symposium on the Management of the Cocoanut Grove Burns at the Massachusetts General Hospital. Roentgenologic Report of the Pulmonary Lesions.** Richard Schatzki. *Ann. Surg.* 117: 841-864, June 1943.

Following the Cocoanut Grove disaster, in Boston, Mass., in November 1942, 39 living patients were admitted to the Massachusetts General Hospital. Within twelve hours after the disaster, it had become apparent that the majority of the survivors were suffering primarily from some pulmonary complication. Thirty-five patients had one and most of them repeated roentgenologic studies of the chest. Pulmonary lesions were found at some time in 22 patients; examination of the other 13 was consistently negative.

The roentgen appearance of the lungs was bizarre and varied from patient to patient. Flame-like areas radiating asymmetrically from one or both hili and bands and lines of increased density were found, as well as areas of increased brightness. The majority of the changes can be explained by the presence of various degrees and amounts of (1) atelectasis and (2) emphysema, both apparently due to bronchial obstruction. In a few other cases there were (3) areas of miliary mottling and (4) areas of diffuse density without decrease in size of the involved portions of the lung ("drowned" lung).

Sudden massive lobar collapse, comparable to post-operative collapse, was seen but once. Another patient showed gradual complete collapse of both lower lobes. More commonly, however, the obstruction was in the smaller bronchi, resulting in collapse of the corresponding lobules, usually visible as triangles or bands of increased density. The majority of the roentgen-positive cases showed localized areas of atelectasis at one time or another.

Several of the patients showed lobular or lobar areas of emphysema during various stages of their pulmonary complication. These were seen best on films in expiration, indicating the presence of trapped air. One case in which persistent lobar emphysema was the outstanding feature is described in detail.

A peculiar mottling, suggesting the lesions following the inhalation of nitrous gases and acid fumes, was seen in two cases. In one there was a diffuse mottling

throughout both lungs, a single lesion measuring from 2.0 to 6.0 mm. in diameter. The lesions were fairly well circumscribed but seemed to be confluent in places. There was also some increase in the linear structures of the lung with several characteristic plate-like foci of atelectasis. This combination of linear shadows and fine mottling suggests to the author that it is at least possible that the appearance was produced by multiple fine areas of atelectasis, together with the actual demonstration of plugged small bronchi. The mottling in the second case was less pronounced and was confined to one lung. Both patients died.

Early in the process three of the survivors showed, in addition to the more characteristic areas of atelectasis, an unusual homogeneous groundglass appearance, covering the lower half of the left lower lobe in one case, the right upper and middle lung field in another, and the central portion of both lungs in the third. The appearance was similar to that occasionally seen in asymmetrical pulmonary edema associated with nephritis or heart failure. The lesion was observed in one case only on the second and third days after the disaster; in the second, only on the first day. In the third case it was present on the second day, decreased gradually and had disappeared entirely on the seventh day. The author believes that this finding can best be explained by the accumulation of fluid in the alveoli distal to points of bronchial obstruction.

Infarcts were not recognized roentgenologically in the first period following the fire, although some may have existed. Acute dilatation of the stomach was found in five patients, and of the esophagus in one patient.

Two of the victims of the disaster, dead on arrival at the hospital, had roentgenologic examination of the chest. In each there was extensive, diffuse, poorly defined haziness extending throughout the greater portion of both lung fields, having the characteristic roentgen appearance of pulmonary edema, the presence of which was confirmed at autopsy. Both the roentgenologic appearance and the postmortem findings in these cases were quite different from those in patients who survived the first twelve hours; in none of the latter cases was extensive pulmonary edema seen.

Numerous roentgenograms are reproduced.

[This paper is followed by one by Tracy B. Mallory and Wm. J. Brickley (pp. 865-884) describing the pathologic changes in the lungs in 6 cases in which post-mortem examinations were done.]

**Atypical (Virus Type) Pneumonia with Cor Pulmonale.** Robert M. Woolford and Joseph H. Ogura. *Ohio State M. J.* 39: 746-747, August 1943.

A case of "virus" pneumonia is reported, occurring in a patient with a previous thoracoplasty for tuberculosis and resulting in anoxemia, cardiac failure, and death. Cor pulmonale was diagnosed clinically and confirmed at autopsy. The authors reconstruct the sequence of events as follows. After thoracoplasty, three years earlier, the strain on the right heart was increased, since almost the whole blood flow was diverted through the remaining (right) emphysematous lung. The vital capacity was further diminished the year before admission, as evidenced by increasing dyspnea. The virus pneumonia decreased the oxygenation of the blood, with consequent cardiac and pulmonary failure.

Oxygen administered by mask reduced the patient's cyanosis but did not relieve the dyspnea. Blood gas

studies showed the CO<sub>2</sub> content to increase progressively, despite this therapy. Marked thickening of the interalveolar septa was considered partially responsible for the CO<sub>2</sub> retention.

LESTER M. J. FREEDMAN, M.D.

**Surgical Management of Solitary Cysts, or Cyst-Like Structures, of Pulmonary Origin.** M. Dawson Tyson. *Ann. Surg.* 118: 50-75, July 1943.

Solitary cysts of pulmonary origin usually first attract attention because of undergoing some accident, such as infection or alteration of the mechanical air-exchange through a connecting bronchus, or rupture of the cyst itself. Frequently the presence of a cyst is not suspected because of the masking of its presence by empyema or tension pneumothorax. A solitary cyst which has become infected is easily mistaken for a lung abscess, and often, in this type of case, the final diagnosis rests with the pathologist.

Seven cases are reported by the author, 6 of which were treated successfully by surgical methods. The seventh case was discovered on routine chest examination, was symptomless, and had not been treated. In each of the 6 treated cases the patient came to the hospital because of some accident to the cyst, and in only 3 instances was a diagnosis of cyst of the lung made on the first examination. The complications were diverse: infection; infection with rupture and consequent pyopneumothorax; progressive expansion of the cyst after the subsidence of infection; rupture of a sterile cyst and formation of tension pneumothorax; rupture of a sterile cyst with discharge of the fluid into the pleural cavity.

In his discussion the author points out that from accounts in the literature, and a review of his own cases, asymptomatic cystic pulmonary lesions are uncommon. In contrast to some, he believes that when they are observed removal should be advised if the patient's condition will permit, because of the likelihood of accidents to the lesion and the development of serious complications.

The best method of treatment is extirpation of the cyst when possible, as simple collapse or drainage may be inadequate, especially if the cyst has an epithelial lining. The scope of the operation may vary, however, from simple excision or enucleation of the lesion itself to lobectomy or even total pneumonectomy. Complete restoration of pulmonary function should be the rule and has been accomplished in all the cases reported by the author.

P. C. BRIEDE, M.D.

**Bronchogenic Cysts of the Mediastinum, with Report of Three Cases.** W. E. Adams and T. F. Thornton, Jr. *J. Thoracic Surg.* 12: 503-516, August 1943.

This paper consists primarily of reports of three cases of bronchogenic mediastinal cysts, all of which were successfully treated surgically. Two of the patients had no symptoms definitely referable to the mass in the mediastinum. The third had a chronic productive cough of four years' duration following an attack of "flu." In all three cases the cyst presented as a smooth rounded mass in the mediastinum toward the right side. Two were at the level of the hilus and one above the aortic arch. All three were just in front of the vertebral bodies. In the patient with the chronic cough an air and a fluid level were visible within the cyst, indicating a communication with the trachea or bronchi.

though this communication was never definitely established.

The mode of development of these cysts is unknown but is probably similar to that of congenital lung cysts. In most of the 32 reported cases there has been no communication with the air passages. Grossly the cysts are thin-walled and filled with a thin, milky, mucoid material under slight pressure. The lining is smooth and consists of flattened to columnar ciliated epithelium. In some places there is no epithelium. The remainder of the cyst wall is made up of fibrous tissue, smooth muscle, numerous glands, cartilage, nerves, and blood vessels.

The clinical course depends on the size and location of the cyst and whether or not it becomes infected. Final diagnosis can be made only by exploration or postmortem examination.

HAROLD O. PETERSON, M.D.

**Isolated Dextrocardia, with Diodrast Studies.** Arthur Ruskin, Herman Tarnower, Berton Lattin, and George P. Robb. *Am. Heart J.* 25: 116-122, January 1943.

A case of congenital isolated dextrocardia, without "mirror-image" inversion of the chambers, but with signs of congenital heart disease and attacks of paroxysmal tachycardia, is reported. Less than 200 cases of isolated dextrocardia (heterotaxia of the heart alone with normal position of all other viscera) have been recorded.

The patient, a 55-year-old woman, gave a history of attacks of palpitation beginning at the age of 35, or earlier, usually accompanied by dyspnea and cyanosis, sometimes by vomiting and teichopsia, and once by hemoptysis. Between attacks, which were diminished in frequency by digitalis, she felt perfectly well.

On physical examination, the point of maximum intensity of the heart beat was felt in the right fifth intercostal space. The right border of the heart was percussed 11 cm. to the right of the midsternal line in the fifth intercostal space and 6 cm. in the third intercostal space. The left border was percussed 2 cm. to the left of the midsternal line in the fourth left intercostal space. The heart sounds were loud; the second sound at the base was louder to the right than to the left of the sternum. A loud systolic murmur and a faint, high-pitched, blowing diastolic murmur were present, being heard best in the right third intercostal space. The systolic murmur was widely transmitted over the entire precordium. No thrill was palpable. The blood pressure was 125/80 in both arms and 140/80 in the legs. The pulsation of the abdominal aorta was felt to the left of the vertebral column. The edge of the spleen was palpable just under the left costal margin, and the liver descended, on inspiration, 4 cm. below the right costal margin.

Teleroentgenograms of the chest showed that the heart was enlarged and that it was in the right thoracic cavity, with considerable bulging of the right supra-ventricular shadow. The aortic knob was on the left. Fluoroscopic examination revealed increased pulsations of the right lower (ventricular) and supra-ventricular shadows. The aortic arch passed over the left main bronchus and descended on the left side of the spine. The aortic pulsations appeared to be normal. There was no "hilar dance." An esophagram showed the usual left aortic arch impression upon the esophagus. The stomach was in normal position.

Roentgenograms taken after the intravenous injection of 50 c.c. of 70 per cent diodrast, according to the technic of Robb and Steinberg (*J. A. M. A.* 114: 474, 1940), showed that the venous auricle and ventricle were on the right side, with a left-sided superior vena cava coursing downward and then to the right of the diaphragm to empty into the right auricle. The outflow tract of the right ventricle formed a prominent pulmonary conus. The left side of the postero-anterior film (taken 10 seconds after the injection) was found to consist of the left ventricle and aorta.

The electrocardiogram was characteristic of isolated dextrocardia.

The diodrast studies in this case clearly demonstrated the relationship of the heart chambers and the left-sided aortic arch. Proof in the past has not been possible without postmortem examination. The authors believe this is the first study of its kind.

**Pericardial Effusion in Myxedema.** George T. Harrell and Christopher Johnston. *Am. Heart J.* 25: 505-511, April 1943.

Two cases of pericardial effusion in association with myxedema are reported, one occurring in a 53-year-old woman and the other in a 62-year-old man. In the first case the pericardial effusion was undoubtedly caused by the myxedema itself, for the fluid disappeared under thyroid replacement therapy, recurred after complete withdrawal of thyroid, did not disappear under digitalis therapy, and responded a second time to thyroid administration, although in a less dramatic manner. The effusion in the second case, in which the heart was more severely damaged, did not respond to thyroid substance alone, but required digitalis also, and did not recur on withdrawal of thyroid and digitalis. In each of these cases there was evidence of underlying arteriosclerotic heart disease.

Both patients showed a hyperchromic, macrocytic anemia, with free gastric hydrochloric acid after histamine stimulation, a low glucose tolerance curve, which quickly became normal with thyroid therapy, and delayed relaxation of the tendon reflexes. The protein and cholesterol content of the pericardial fluid was less than that of the blood. Leukocytes, especially polymorphonuclears, were present in the fluid.

Roentgenkymograms made in the first case showed absence of pulsation over the lower third of the heart, with good pulsations over the great vessels; they indicated no impairment of ventricular contraction, even when pericardial effusion was developing after incomplete withdrawal of thyroid therapy. The pulsations over the great vessels were greatly reduced after entire cessation of thyroid therapy and the development of massive pericardial effusion. The author states that "study of additional cases of myxedema heart by means of the roentgenkymograph, and perhaps other methods, may produce evidence that muscular relaxation is impaired in the ventricle as well as in skeletal muscle."

**Constrictive Pericarditis Due to Bacterium Tularensis. Report of a Case and Review of Reported Cases of Pericarditis Occurring with Tularemia.** B. V. Jager and J. C. Ransmeier. *Bull. Johns Hopkins Hosp.* 72: 166-178, March 1943.

The authors report a case of tularemia of the typhoidal type with evidence of pleuritis and pneumonia, complicated by a constricting pericarditis which persisted after clinical recovery from the febrile illness.



A 22-year-old white farmer had a chronic febrile illness which was not associated with lesions of the skin, mucous membranes, or lymph nodes. At the onset the symptoms and signs suggested infection of the lungs and pleura. Later, dyspnea on exertion became a prominent symptom. Two and one half months after the onset, the patient entered the hospital, where he was found to have pericardial and pleural effusions. At this time his serum agglutinated *B. tularensis* to a dilution of 1:160. Following withdrawal of a small amount of fluid from the pericardial sac, air was injected at the site. A roentgenogram demonstrated the presence of a small amount of fluid and air in a greatly thickened pericardial sac. For the first three weeks of hospitalization there were signs of increasing pericardial constriction associated with bilateral pleural effusions. At the end of this time the antitularense titer of the patient's serum had risen to 1:1,280. During the fourth week, a transfusion from a patient convalescent from tularemia was followed by evidence of clinical improvement. At the time of discharge from the hospital, constrictive pericarditis persisted without roentgen evidence of fluid in the pericardial sac. *B. tularensis* was recovered from the pleural fluid by direct culture. In addition, there was suggestive evidence that this organism was present in the pericardial fluid.

The roentgenograms which were taken through the course of the illness are fully described. The manifestations of 9 additional cases of pericardial involvement in tularemia are tabulated and discussed.

**New Apparatus for Stereoscopic Fluoroscopy: the Stereoroentgenoscope. II. Orthodiagraphy with the Stereoroentgenoscope.** Max Hopf. Schweiz. med. Wchnschr. 73: 975-977, Aug. 7, 1943.

The author gives some general discussion of the standards for heart volume estimation from orthodiagraphic diameters. He believes that the advantages of determining these diameters by stereoscopic fluoroscopy are five: (1) the tracing can be made with open shutters, permitting simultaneous observation of the whole heart and thoracic contents; (2) the free observation makes it possible to obtain all desired average measurements; (3) cross hairs are not required; (4) no special screen or tube assembly for central beam projection is needed, and both hands remain free for manipulation; (5) the arrangement tends to obviate mechanical errors.

For a description of the author's stereoroentgenoscope, see an earlier paper (Schweiz. med. Wchnschr. 72: 1283, 1942. Abst. in Radiology 41: 415, 1943).

LEWIS G. JACOBS, M.D.

**Cardiac Aneurysm: Report of a Case with Correlation of Clinical, Radiological and Electrocardiographic Findings.** Driver Rowland. Ann. Int. Med. 19: 349-356, August 1943.

The author reports a case of cardiac aneurysm, diagnosed clinically, in a patient with typical symptoms of coronary occlusion, electrocardiographic findings indicating right axis deviation, and roentgen evidence of cardiac enlargement, chiefly involving the left ventricle. The region of the apex was elongated, and there was a total absence of pulsation in this area. With the patient turned very slightly, in left oblique view there was seen in this region a slight bulging with each systolic contraction of the heart.

About 85 per cent of ventricular aneurysms are said

to follow cardiac infarction subsequent to the occlusion of a coronary artery. Roentgenography, more especially fluoroscopy, is generally considered as offering the best means of diagnosis, though not all authorities are in agreement on this point. The author quotes Parkinson *et al.* (Quart. J. Med. 7: 455, 1938) as listing the following radiographic signs.

- (1) Enlargement of the left ventricle with deformity of its contour.
- (2) A localized protuberance inseparable from the heart shadow on rotation of the patient.
- (3) Abnormal or absent pulsation of the aneurysmal zone.
- (4) Evidence of adhesions between the heart and chest wall.
- (5) Calcification of the wall of the sac or contained clot.

The most characteristic finding is an abnormal bulge projecting from the surface of the left ventricular border. This is particularly diagnostic if one of the following signs is observed fluoroscopically:

- (1) A diminished or total lack of pulsation in this region.
- (2) A paradoxical pulsation in the region of the supposed aneurysm, *i.e.*, a systolic expansion of this area.
- (3) Calcification of the pericardium or wall of the aneurysm.

Rotation of the patient into various oblique positions under the fluoroscope is invaluable. The right oblique view is best for demonstrating aneurysms of the anterior surface, the left for lesions on the posterior surface.

Electrocardiographic changes are discussed in detail. A right axis deviation is believed to be of frequent occurrence. Its presence in association with left ventricular enlargement is especially significant. A systolic pulsation separate and distinct from the apex pulsation is also strongly suggestive of cardiac aneurysm, as pointed out by various observers.

The author believes the majority of cases can be diagnosed antemortem by thorough correlation of the clinical, electrocardiographic, and roentgen findings.

STEPHEN N. TAGER, M.D.

**Two Cases of Dissecting Aneurysm of the Aorta, with Ante-Mortem Diagnosis.** M. E. Thomas and A. Elizabeth Garber. Am. Heart J. 25: 407-414, March 1943.

Among 283 patients with hypertension of various kinds seen in the Lilly Laboratory for Clinical Research during the past four years, 2 had dissecting aneurysm of the aorta. These 2 cases are presented in detail; in each the diagnosis was made clinically. The authors also review 151 cases reported in the American literature since Shennan's report in 1933 (British Medical Research Council, Special Report Series No. 193).

Dissecting aneurysm is associated with hypertension in the majority of cases; coronary disease, with subsequent occlusion, is also frequently observed in association with high blood pressure but, while the symptoms in the two conditions are similar, the prognosis is quite different. The authors stress the following points in the differential diagnosis. A consistently high blood pressure should cause one to question a diagnosis of coronary occlusion. A continued agonizing pain, radiating from the area of dissection of the aorta, is the

most outstanding symptom of aneurysm. Pain, with temporary paralysis of the extremities, is usually caused by actual dissection of the main artery, thrombosis of a vein, or embolism. The pain of coronary occlusion seldom radiates below the sacrum, but that of dissecting aneurysm commonly radiates to the legs. Associated with the pain are coldness and diminution or absence of the pulsations of the arteries. The latter may be transient. There is a peculiar grayish cyanosis which accompanies the patient's appearance of anxiety. This is not relieved by the administration of oxygen.

The temperature may be subnormal if the patient is in shock, or it may be moderately elevated. There is usually an increased leukocyte count. Of 20 patients in whom an erythrocyte count was recorded, 16 had a progressive anemia. There is no typical electrocardiographic pattern.

Any patient with hypertension should have a roentgenogram of the chest. If there is abnormality of the cardiac, aortic, or mediastinal shadow, subsequent roentgenograms may disclose progressive enlargement. Fluoroscopic examination is usually an aid in the diagnosis of aneurysm. In the authors' cases roentgenographic and fluoroscopic examination of the chest showed widening of the aorta and mediastinum. Thirty-one of the 151 patients had roentgen abnormalities suggestive of dissecting aortic aneurysm; 115 had no roentgen examination; only 5 had normal shadows.

**Congenital Aneurysmal Dilatation of the Aorta Associated with Arachnodactyly.** Ridgely W. Baer, Helen B. Taussig, and Ella H. Oppenheimer. *Bull. Johns Hopkins Hosp.* 72: 309-331, June 1943.

Two cases of arachnodactyly are reported in which there was extraordinary aneurysmal dilatation of the ascending aorta.

One patient was under observation from birth, when it was noted that the eyes were unusually prominent and the fingers and toes abnormally long. Examination, at the age of 13, one year before death, revealed a thoracic and lumbar scoliosis and shortening of the chest. The heart was enlarged and lay transversely, causing a deformity of the left chest. There was a loud systolic murmur. The chest deformity and displacement of the heart rendered it difficult to evaluate the roentgenographic and fluoroscopic findings, but there was evidence of great enlargement of the heart, particularly of the left auricle and left ventricle. Upon the administration of barium the esophagus could be seen to be displaced backward by the left auricle. Necropsy showed aneurysmal dilatation of the ascending aorta, proximal to the aortic arch, but this was not detected either on fluoroscopic examination or by x-ray.

The second patient was a colored man, admitted to the hospital at the age of 25 years. Examination revealed a 2-inch shortening of the left leg, with consequent thoracic and lumbar scoliosis. The inner ends of both clavicles were slightly dislocated upward. The fingers were moderately long and tapering and slightly webbed. There were bilateral hallux valgus and several hammer toes. A defect in the arch of the sacrum was demonstrable by palpation and x-ray. Roentgen examination showed enlargement of the heart, especially in the region of the left ventricle, and a moderately enlarged pulmonary conus. Neither the aorta nor the left auricle impinged upon the barium-filled esophagus. Death occurred eleven months after the first hospital admission.

The necropsy findings in the second case closely paralleled those in the first patient. The two hearts were almost identical. Both were much enlarged, the left auricle in each instance being so greatly stretched that the valve covering the foramen ovale no longer completely closed it. In each the aortic ring was dilated and the coronary orifices were displaced upward. In each, also, there was a tremendous dilatation of the proximal part of the aorta. Histologic examination of the aorta in both patients revealed a malformation of the media, which the authors believe to have been congenital.

**Syndrome of Rupture of Aortic Aneurysm into the Pulmonary Artery: Review of Literature with Report of Two Cases.** Richard E. Nicholson. *Ann. Int. Med.* 19: 286-325, August 1943.

The antemortem diagnosis of aortic aneurysm rupturing into the pulmonary artery is rare, chiefly because of unfamiliarity with the syndrome or because the possibility of its presence is discarded in favor of a greater statistical probability. Eighty-one cases were found in the literature and details of these, as well as the 2 reported here, are presented in tabular form. Of 65 cases in which the sex was mentioned 59, or 91 per cent, occurred in males. This preponderance in the male sex is due probably to the higher incidence of aneurysms in men and the greater physical strain to which they are subject.

The criteria for the syndrome are briefly summarized: sudden onset with severe stabbing pain or a sense of oppression in the precordial area, usually following physical exertion; gradually increasing dyspnea; progressive swelling of the lower extremities and trunk; rasping cough with expectoration or hemoptysis; cyanosis or extreme pallor of the face and extremities.

Objective signs include an intense thrill in the second to third left interspace during systole or throughout the cardiac cycle; a humming "machine-like" murmur continuous throughout the systolic and diastolic phase, crescendo-decrescendo in character; evidence of aortic aneurysm with Corrigan's pulse and increased cardiac rate. Roentgenograms reveal an aneurysmal sac of varying size extending to the left of the sternum and an associated dilatation of the pulmonary conus. In most instances the heart is diffusely enlarged. In the author's cases increased pulsations of the pulmonary vessel and conus were observed fluoroscopically. In one patient diodrast studies showed the fistula with enlarged pulmonary conus and vessels. Electrocardiographic studies have been reported in six cases, but were non-specific and showed no points of similarity.

[The two cases recorded in this paper are also the subject of a report by Schattenberg and Harris in the *American Heart Journal*. The abstract of that paper, which follows, describes the cases in some detail.]

STEPHEN N. TAGER, M.D.

**Aortic Aneurysm with Rupture into the Pulmonary Artery.** Herbert J. Schattenberg and William H. Harris, Jr. *Am. Heart J.* 25: 512-521, April 1943.

Two cases of aneurysm of the arch of the aorta, due to syphilis, with rupture into the pulmonary artery, are reported in detail—the only two instances of rupture into the pulmonary artery in a series of 1,595 aneurysms of the thoracic aorta seen at the Charity Hospital, New Orleans, over a period of thirty-six years. There

were approximately 132 ruptures during this period, giving an incidence of rupture into the pulmonary artery of only about 1.5 per cent, a somewhat lower figure than reported elsewhere.

One patient was a 40-year-old colored woman, the other a 40-year-old colored man. Symptoms in the first case—palpitation, weakness, swelling of the ankles, abdominal pain, intermittent precordial pain, radiating to the left flank, and frequent attacks of unconsciousness—began two and one-half months previous to admission to the hospital, which was three months before the patient's death. On admission, the continuous, "humming top" murmur, peculiar to a ruptured aneurysm, was noted. A roentgenogram of the chest, taken at this time, showed an enlargement of the cardiac shadow and evidence of an aneurysm of the arch of the aorta. X-ray examination with diodrast showed what appeared to be an enlargement of the pulmonary artery. Autopsy revealed rupture of the aneurysm into the left pulmonary artery—the second instance of its kind to be reported in the literature. Also, the aneurysm was in the *transverse*, rather than the ascending portion of the aorta. In view of the pathologic changes, it is believed that rupture in this case occurred some time before death, possibly during an attack of dyspnea and chest pain.

The second patient was admitted to the hospital fifteen hours before death, with a history of a slight non-productive cough of three months' duration and a loss of 18 pounds in the previous month. Five days prior to admission he noticed a "snap in his chest," which was associated with pain in the left shoulder and increasingly severe dyspnea. A roentgenogram of the chest showed widening of the mediastinal shadow at the base of the heart and just above this area. Autopsy revealed an aneurysm in the ascending portion of the aortic arch, with compression and destruction of the wall of the left pulmonary artery. Rupture occurred into the pulmonary artery at its bifurcation.

**Dissecting Aneurysm of the Abdominal Aorta.** Eugene DeAngelis. *Am. Heart J.* 26: 124–128, July 1943.

A case is reported in which a provisional antemortem diagnosis of a dissecting saccular arteriosclerotic aneurysm was made. The surgeons considered it as a pancreatic or peritoneal cyst. A laparotomy was done, and an aneurysm was discovered above the bifurcation of the abdominal aorta. Death occurred post-operatively, and the postmortem findings relating to the aneurysm are given.

The patient gave a history of vague abdominal distress for over thirty years. During the three years prior to hospital admission he suffered from recurrent attacks of severe, agonizing, vise-like pain, which began in the epigastrium, radiated upward involving the entire chest and back, and then spread to the neck and head and down the upper extremities to the finger tips. For eighteen months an abdominal mass had been palpable, which had increased to the size of a grapefruit. The mass was tense, immovable, with no thrill and no expansile pulsation.

Roentgen examinations of the chest and the gastrointestinal tract revealed an enlarged heart, dilated and tortuous thoracic aorta, and evidences of external pressure against the lesser curvature of the stomach.

The etiologic factors were arteriosclerosis and hypertension. An occupational trauma is suggested as a

possible contributing factor—repeated pressure from the end of a draftsman's board over a period of years against the abdomen, and indirectly against the atherosclerotic abdominal aorta.

This is said to be the second case in which a dissecting aneurysm beginning in the abdominal aorta was diagnosed before death.

HENRY K. TAYLOR, M.D.

**Juvenile Elongation of the Aorta.** F. Y. Khoo. *Am. Heart J.* 25: 404–406, March 1943.

A 12-year-old boy was admitted to the hospital suffering from a traumatic dislocation of the right wrist, due to a fall three years earlier, with chronic osteomyelitis. Discharging sinuses had been present for about two years. Routine fluoroscopic examination of the chest revealed an elongated and tortuous aorta, with its upper end extending well into the left upper lung field, and prominence of both ventricles, especially the left. Pulsations appeared normal. The retrocardiac space was clear. A roentgenogram taken with a target-film distance of 250 cm. confirmed the fluoroscopic observations. The heart appeared slightly wider and larger than normal; the general outline was somewhat sabot-shaped, with moderate rounding of the left border and less of the right. The elongated aorta had a rather tortuous knob, the superior border of which corresponded in level to the fourth thoracic vertebra. The cardiothoracic ratio was 0.54, and the width of the aortic shadow 5.4 cm. There was no history of cardiovascular disease, and no evidence of congenital syphilis.

In the absence of other significant findings, the author feels that the unusual appearance of the aorta and heart might be explained by a congenital abnormality or by some juvenile degenerative or hypertrophic change brought about by unknown factors (toxic?) which were perhaps related to the chronic infection of the wrist.

## THE DIGESTIVE SYSTEM

**Deformities of the Duodenum Other than Those Due to Ulcer.** John T. Farrell, Jr. *Pennsylvania M. J.* 46: 1149–1151, August 1943.

Most deformities of the duodenum are due to ulcer. Other causes are listed as diverticulum, duodenal redundancy, duodenitis, adhesions, foreign body, polyp, new growth, and extraduodenal pressure.

Diverticula are usually asymptomatic, but may be the cause of indigestion. They sometimes undergo ulceration, with the usual pain and tenderness. The roentgen picture is that of a smooth, localized pouch in which the contrast medium is retained for a variable time after the main stream has passed. There is no fluid level. When ulceration occurs, differentiation from duodenal ulcer may be difficult. It is unusual, however, for barium to remain in an ulcer niche.

In congenital redundancy of the duodenum, the lengthening is usually in the second portion and is best shown in the erect position.

Duodenitis is characterized by a constantly changing deformity of the duodenal cap.

Inflammatory adhesions due to disease of the gall-bladder or duodenal ulcer will smooth the normal "feathering" due to the valvulae conniventes. Visualization of all portions of the duodenum at one time is a sign of obstruction.

Long foreign bodies that are sharp or pointed may become lodged at the junction of the second and third

portions of the duodenum. In these instances the opaque stream usually coincides with the foreign body.

Benign tumors produce a circumscribed filling defect. Cancer of the duodenum is seldom recognized until it has produced obstruction, in which event there is delay in the proximal portion of the duodenum and gastric retention.

Tumors of the gallbladder, pancreas, and colon may produce extraduodenal pressure. Carcinoma of the head of the pancreas may deform the duodenum in such a way that it resembles an inverted 3.

JOSEPH T. DANZER, M.D.

**Roentgenologic Diagnosis of Carcinoma of the Colon.** L. W. Baird. *Texas State J. Med.* 39: 243-246, August 1943.

Carcinoma is the most frequently encountered tumor in the colon. It is being recognized in its earlier stages more often because of increasing accuracy of roentgen diagnosis and the prevailing tendency toward early roentgen examination in vague abdominal disorders of questionable etiology.

Barium meal examination is unsatisfactory and in the presence of obstruction is dangerous. It should be used only as a complementary method following a contrast enema if the lesion occurs in the cecum or terminal ileum.

In barium enema studies, carcinoma is indicated by an abrupt change in mucosal pattern affecting a relatively short segment of colon, by an eccentric narrowed bowel channel, and by hooks in the barium shadow at one or both ends of this segment. Polypoid carcinoma produces a lobulated, cauliflower-like filling defect rather than lumen deformity and is best demonstrated by means of a double contrast examination.

Granuloma or inflammatory tumefaction produces no typical roentgen findings and is diagnosed by the absence of the above criteria.

When carcinoma is complicated by complete obstruction, perforation, or secondary infection, the diagnosis becomes increasingly difficult. Inflammatory processes involve a longer segment of bowel and the sharp demarcation between normal and diseased colon is lost. Close scrutiny, however, often reveals an area within the affected segment sufficiently characteristic to justify a diagnosis of malignant neoplasm. Complete obstruction occurs more commonly in the left colon. Usually, overdistention of the distal colon with barium, air, or both, will produce two convex smooth spurs in the normal bowel shadow on each side of the central constriction. The author states that this sign is pathognomonic of carcinoma. With obstruction low in the sigmoid, endoscopy is frequently required for diagnosis.

Of 100 consecutive tumefactive lesions of the colon seen roentgenologically in the past four years at the Scott & White Clinic (Temple, Tex.), 86 were primary carcinomas, 10 were inflammatory granulomas, and 4 were extrinsic malignant lesions, with secondary involvement of the colon. Seventy-six of the primary carcinomas were correctly diagnosed, including 19 cases with perforation and 13 cases with complete obstruction. Of the remaining 10 carcinomas, 2 showed complete obstruction in the distal sigmoid and 7 were complicated by perforation and abscess formation with no specific diagnostic findings. Characteristic roentgen signs of primary carcinoma were absent in the 10 cases of granuloma and in the 4 cases of extrinsic neoplasm.

LESTER M. J. FREEDMAN, M.D.

**Motor Changes Observed Fluoroscopically in the Colon of a Patient Afflicted with a Tumor in the Hypothalamic Region.** A. Mayoral. *Am. J. Digest. Dis.* 10: 305-307, August 1943.

A 52-year-old man entered the hospital with symptoms of progressive weakness, headaches, nausea and vomiting. Fluoroscopic observation following a barium enema showed marked spasticity in the transverse colon with forcible propulsive movements. The findings are described as being similar to those of cecal tuberculosis or an amebic infection, though the patient had no known tuberculous focus and stool examinations for amebae and occult blood were negative. Death occurred about six weeks later, from cerebral hemorrhage, and autopsy revealed a tumor of the hypothalamus. The gastro-intestinal tract was normal.

It has been proved by both clinical and experimental investigation that tumors in or near the hypothalamus cause severe motor disturbances of the gastro-intestinal tract. In the absence of amebic or bacillary dysentery, extreme irritability of the colon as described may be of some value in diagnosing a lesion of the hypothalamus.

JOSEPH T. DANZER, M.D.

**Spread of Carcinoma of the Rectum: Invasion of Lymphatics, Veins and Nerves.** Philip H. Seefeld and J. Arnold Bagen. *Ann. Surg.* 118: 76-90, July 1943.

This paper reports a study of 100 operative specimens of rectal carcinoma and an attempt to correlate the presence of perineural invasion, venous invasion, and nodal spread with the available clinical data.

The lymph nodes were involved in 47 per cent, nerves in 30 per cent, and veins in 20 per cent. The incidence of invasion in all types increased with the degree of malignancy. Perineural invasion and venous invasion were more frequent among men, while lymph node involvement was equally distributed between the sexes. There seemed to be a higher frequency of nodal and venous involvement in the younger patients. Invasion of the nerves was not related to the location of the lesion, while venous invasion was most frequent in lesions high in the rectum and nodal invasion was more frequent in lesions of the middle segment. Pain was a prominent symptom in 89 per cent of the cases in which there was invasion of the nerves, while 50 per cent of those without demonstrable nerve involvement complained of pain.

Local recurrence was more than two and one-half times as frequent in the cases in which the nerves were invaded as those in which there was no involvement. Visceral metastatic lesions occurred in 94 per cent of the patients who had venous invasion in the primary growth and were five times as frequent as in those without. Eighty per cent of these died from carcinoma, either recurrent or metastatic.

These conclusions are of prognostic significance especially in patients in whom no venous invasion can be demonstrated in the primary lesion. In this series, visceral metastasis occurred in only 18.7 per cent of those cases in which venous invasion was absent in the primary growth.

P. C. BRIEDE, M.D.

**Gallstone Ileus. Recurrence in One Case.** B. Hollis Hand and William E. Gilmore. *Am. J. Surg.* 59: 72-78, January 1943.

Because of its extremely high mortality, gallstone ileus should receive early surgical treatment. Although

the condition may be strongly suspected because of gallbladder disease associated with a bizarre type of intestinal obstruction, a conclusive diagnosis can scarcely be made preoperatively without the aid of x-ray. The most helpful roentgen sign is probably gas or opaque material in the biliary tree, indicating the likelihood of an internal biliary fistula. A stone in a dilated intestine is not often visualized, but when seen is almost conclusive of gallstone ileus. If a biliary fistula can be demonstrated in the presence of intestinal obstruction the diagnosis is fairly certain.

The author presents three cases of gallstone ileus. The preoperative diagnosis was suggested in one case and was made with certainty by the aid of x-ray in the others. One patient had a recurrence within the first week of convalescence, which was likewise diagnosed and treated successfully.

**Intestinal Obstruction Due to a Gallstone.** Robert L. Nitkin and Albert Lesser. *Ann. Surg.* 118: 101-106, July 1943.

This is essentially a case report of acute intestinal obstruction caused by a large calculus in the lower ileum following a cholecystoduodenal fistula. The fistula as well as the obstructing stone was demonstrated on the roentgenograms after the injection of barium through a Miller-Abbott tube and subsequent removal by the same method.

The usual roentgenological signs of this condition are (1) air or contrast medium in the biliary tract; (2) complete or partial intestinal obstruction; (3) demonstration of the stone on a plain film or following a barium meal; (4) change in position of a previously observed stone.

### THE BILIARY TRACT

**Study of the Significance and Accuracy of Cholecystographic Findings.** A. M. Serby and Gemma M. Lichtenstein. *Am. J. Digest. Dis.* 10: 300-301, August 1943.

In the interest of correlating cholecystograms with operative findings, a study was made of the roentgenographic and surgical observations in 278 cases. According to the cholecystographic findings the cases were divided into five groups, with some overlapping.

**Group I:** One hundred and sixty cholecystograms showed stones, representing 72 per cent of the cases in which cholelithiasis was found at operation. Nine cases (5.1 per cent) showed shadows that were assumed incorrectly to be due to stones.

**Group II:** One hundred and three cholecystograms failed to show stones. Stones were found in 64 of these cases at operation. In 54 of the 64 cases, there was poor concentration of dye in the gallbladder, or none at all.

**Group III:** One hundred and twelve cholecystograms showed no dye concentration; 68 of these showed gallstone shadows, and gallstones were found in 64 of this group, an error of 6 per cent. Gallstones were also found in 36 of the 44 cases without suggestive shadows.

**Group IV:** Eighty-nine cholecystograms showed poor dye concentration; 61 of these showed stones, and in all of these cases stones were found at operation. Of the 28 patients without cholecystographic evidence of stones, 18 were found to have cholelithiasis on operation.

**Group V:** Thirty cholecystograms showed fair or good concentration with no stones. Twenty patients in this group were found to have no stones.

The authors conclude that a well filled gallbladder without evidence of stones is generally found to be normal at operation. A poor filling gallbladder many times contains stones that are not demonstrable. Poorly visualized gallbladders frequently become well outlined when the examination is repeated.

JOSEPH T. DANZER, M.D.

**Visualization of the Biliary Tract with Air and Barium Following a Barium Meal.** Daniel B. Faust and Chas. S. Mudgett. *Ann. Int. Med.* 19: 356-367, August 1943.

The following case is apparently unique in the literature in that there was a simultaneous demonstration of the biliary tract and a gallbladder emphysema without the presence of a fistula.

A man aged 46 years was admitted to the hospital Dec. 26, 1939. In 1938 a cholecystogram had shown a non-functioning gallbladder without calculi. For ten days prior to admission, the patient suffered almost daily attacks of severe pain in the right upper quadrant, radiating to the back and to the right shoulder, and relieved by alkalies. The stool was not clay-colored.

Repeated studies of the gastro-intestinal tract following a barium meal, alone and combined with a cholecystogram, revealed a constant deformity of the second portion of the duodenum, with a reflux of opaque material into the common, cystic, hepatic, and pancreatic ducts, and the gallbladder. The latter organ was outlined by the dye and showed a fluid level and the presence of air. At six hours, a small amount of barium remained in the gallbladder and common duct.

Because of the possibility of a duodenal ulcer or polyp, an exploratory laparotomy was performed on Jan. 17, 1940. No polyp, tumor, or ulcer was found. The gallbladder was adherent to the second portion of the duodenum and was easily freed. No stones could be palpated in the gallbladder or common duct. A large tube passed easily without obstruction through the first and second portions of the duodenum. With the institution of dietary measures following operation the symptoms improved.

On Feb. 13, 1940, a combined cholecystogram and gastro-intestinal series showed the same findings as prior to operation. The patient continued, however, to be free from acute pain and flatulence.

The findings in this case are attributed to incompetency of the sphincter of Oddi with general atony of the entire biliary tract. Traction from the cholecystoduodenal adhesions may have played a part in producing incompetency of the sphincter of Oddi. The appearance of air in the gallbladder is generally due either to a gas bacillus infection of the gallbladder or to a fistulous communication between the biliary and gastro-intestinal tracts. Neither condition existed here.

The literature on gallbladder emphysema and visualization of the biliary tract following a barium meal is reviewed.

STEPHEN N. TAGER, M.D.

**The Perforating Gall Bladder: Report of 24 Cases.** N. Frederick Hicken and Q. B. Coray. *Rocky Mountain M. J.* 40: 524-529, August 1943.

Contrary to accepted belief, perforation or spontaneous rupture of the gallbladder is of frequent occurrence

The authors quote statistics from various clinics giving the incidence of perforation during the course of acute cholecystitis as from 22 to 40 per cent. In their own series of cases this complication ensued in 25.6 per cent of patients with acute gallbladder disease treated surgically. In 50 per cent of their 24 cases of perforation, pressure of a calculus was the exciting factor.

These perforations do not occur with explosive violence, but have a slow, progressive onset, being invariably superimposed on a chronically diseased gallbladder. In view of this, a plea is made for the removal of gallstones whenever encountered. The authors cite Heuer's analysis of a collected series of 508 perforations with an operative mortality of 40 per cent (*Ann. Surg.* 99: 881, 1934) and compare this figure with the 0.5 to 1.5 per cent operative mortality in uncomplicated lithiasis. They believe also that acute cholecystitis calls for immediate operation and deplore the practice of waiting for the acute manifestations to "cool off," since one can never be certain which cases will go on to perforation.

In their discussion of operative management they state that it has usually been necessary, in addition to removal of the gallbladder, to drain pericholecystic abscesses, remove choledochal stones, or decompress the common duct. Best and Hicken have demonstrated the futility of simply draining the gallbladder in such cases.

In order to determine the functional status of the biliary tree the authors have been in the habit of making routine cholecystograms before operation. They inject 10-30 c.c. of diodrast into the common duct and take films immediately. If the ducts are shown to be patent, if they harbor no stones, and if the diodrast flows uninterruptedly into the duodenum, no further attention need be given to these structures. If intra-ductal stones are shown, however, they are removed without delay. When the choledochus is dilated and the swollen pancreas prevents the diodrast from passing through the ampulla of Vater, it is advisable to drain the congested ducts. All investigations are made before the gallbladder has been molested.

If the condition of the patient seems to make it imperative, cholecystotomy is performed though cholecystectomy is considered the operation of choice. Sometimes the Thorek operation is employed (electrocoagulation). A large Penrose drain is placed in the operative area. All choledochal drains and tubes are brought out through stab wounds, to provide dependent drainage. Sulfa drugs are used in many of the cases. In those cases having an associated cholangitis, the drains are not removed until the roentgenograms demonstrate the ampulla of Vater to be patent; sometimes these tubes are left in place for as long as ten weeks. The average period of hospitalization in the authors' series was nineteen and a half days.

In 22 operations for perforated gallbladders there were but 2 deaths, giving the low mortality rate of 9 per cent. On the other hand, 2 patients died while waiting for the referring physician or relatives to give operative consent.

PERCY J. DELANO, M.D.

### THE PERITONEUM

**Left Subdiaphragmatic Abscess: Report of a Case.** Gervase J. Connor. *Yale J. Biol. & Med.* 15: 905-912, July 1943.

Connor gives a detailed description of the signs and course of an abscess of the superior subdiaphragmatic

space on the left side, with serial chest x-rays accompanying the report. He states that left subdiaphragmatic abscess frequently exhibits a course different from an abscess on the right. Since the stomach is relatively mobile, elevation of the diaphragm may be late, and basilar pulmonary atelectasis and pleural effusion may also be delayed. The first sign of importance is tenderness over the subdiaphragmatic space. If this is involved anteriorly, earlier diagnosis is possible, as this region is more accessible to palpation. If the abscess is posterior or superior, tenderness is present over the 11th or 12th rib. This may be minimal and sharply localized. Basilar atelectasis soon appears, but is minimal. Elevation of the diaphragm, restricted mobility, tenderness to palpation, and other evidence of an infectious process permit a diagnosis. A pleural effusion often indicates a late phase of abscess development.

SIDNEY LARSON, M.D.

### THE SUPRARENAL GLANDS

**Laminography in the Visualization of the Suprarenal Glands.** Seymour F. Wilhelm. *J. Urol.* 49: 785-788, June 1943.

In an attempt to visualize the suprarenal gland, laminography following perirenal insufflation has been tried by the author and found to be practical and useful. The laminographic examination was made in the anteroposterior projection. The normal suprarenal gland shadows were most clearly outlined at a surface lying from 6 to 10 cm. above the table top. In the cases of suprarenal gland enlargement, the most striking views varied at different levels, depending on the size and location of the mass. Although the depth at which the kidney lies varies with the thickness of the posterior abdominal wall, it is usually unnecessary to attempt to delineate the structures at a plane less than 5 cm. or more than 12 cm. above the table top.

Plain films and laminagrams were made following perirenal insufflation in 9 patients who were suspected of suffering from disease of the suprarenal gland. Fifteen insufflations were done, since 6 patients had bilateral studies. In 2 instances the injected air failed to diffuse sufficiently and the outline of the suprarenal gland could not be seen either on the simple film or on the laminagram. The suprarenal gland appeared normal on 8 laminagrams and on 3 was moderately enlarged. In all but one of these cases, the suprarenal gland was more sharply and more clearly delineated on the laminagram than on the simple film made after the air injection. In some instances the shadow of the suprarenal after insufflation could not be clearly determined by the usual simple film examination but was very clearly outlined by the laminographic technic. In two patients, the shadow of a large neoplasm of the suprarenal gland, later confirmed at operation, was clearly visible both on the simple film and on the laminagram. The author has found this procedure of particular value in the delineation of the normal suprarenal gland and in the determination of lesser enlargements.

**Bilateral Carcinoma of the Adrenal Cortex with Metastasis to the Iliac Bone.** Mather Cleveland and Leila C. Knox. *Arch Surg.* 47: 192-202, August 1943.

A white man aged 57 complained of pain in the right hip for six months. General examination, including

blood pressure estimation, was normal. There were no sexual abnormalities. A mass in the region of the right iliac crest was associated with x-ray evidence of bone destruction; the chest appeared clear. A pre-operative diagnosis of malignant tumor was made and an exploratory operation was undertaken. This lasted about twenty-five minutes. Two hours later the patient went into shock, which persisted until death on the second postoperative day. At autopsy bilateral carcinoma of the adrenal cortex, reticular type, with destruction of both adrenals and metastasis to the ilium and gluteal muscles was demonstrated.

The first report of a case in some measure similar was in 1896 by Affleck and Leith (Edinburgh Hosp. Rep. 4: 278, 1896). Some confusion exists in the earlier case reports, as the frequency of metastasis to the adrenals from bronchial carcinomas was not originally recognized. Nevertheless, the authors found 49 cases of adrenal carcinoma in the literature suitable for review. The distribution between the sexes is about even, and the incidence is highest in the fourth and fifth decades. Of the 49 recorded cases, only 5 were bilateral, and in 4 of these one of the tumors may have been a secondary growth, leaving only one case closely resembling the authors'. Symptoms were highly variable. The biologic effects of the abnormal hormones were more common in women, often leading to a syndrome resembling that of Cushing's pituitary basophilism with amenorrhea, obesity or loss of weight, and skin changes with hypertrichosis and striae. Polycythemia, hypertension, headaches, and masculinization may be present. In the male corresponding symptoms are less well defined. Skeletal changes, especially osteoporosis, are common; the condition of the bones may resemble fibrocystic dysplasia.

The prognosis of adrenal tumors is poor, but operation may be successful if the ensuing adrenal insufficiency is vigorously combated. Metastases are most commonly observed in the lungs, liver, and lymph nodes.

LEWIS G. JACOBS, M.D.

## THE SKELETAL SYSTEM

**Roentgenological Manifestations of Bone Repair. Healing of Fractures Without External Callus.** Robert G. Vance and George M. Wyatt. *Am. J. Surg.* 59: 404-407, February 1943.

The physiological process of bone repair following fracture may be summarized briefly as: (1) hemorrhage in and about the fracture; (2) decalcification and resorption of devitalized bone; (3) ingrowth of granulation tissue about the fracture; (4) formation of osseous and, to a variable degree, cartilaginous matrix; (5) calcification and organization of this matrix to form bony union; (6) shaping of the new bone to its final contour.

Roentgen examination can accurately demonstrate only the alterations in the amount and distribution of calcium in the region of the fracture. The other phases of bone repair can, however, be largely inferred from the roentgen appearance, with the understanding that the changes visible on the films are gross and lag considerably behind the histologic process. If serial roentgenograms are made, a decrease in the density of the fracture margins will be seen at about the tenth day. After two or three weeks, or sometimes earlier in children, calcification in the matrix surrounding the margins of the fracture may be observed. This fusiform calcification, or external callus, gives assurance that healing is

progressing normally. At the same time internal or intermediate callus is forming between the margins of the fracture. This is not so clearly visible in the roentgenogram as external callus, due to the density of the adjacent bone and absence of a soft-tissue background.

Fractures in any location may occasionally heal firmly and promptly without showing external callus roentgenographically, but such healing is the rule in fractures which lie within joint capsules. It also takes place frequently in fractures which extend into joint capsules even though part of the fracture lies outside of the capsule. It is, therefore, fallacious to assume that a fracture is of recent origin merely because no external callus is demonstrable.

The recognition of healing without external callus is important for the following reasons: (1) If it is inferred that union is not taking place simply because no external callus is visible roentgenologically, the physician and patient may become unduly discouraged. (2) If union without external callus is not recognized, immobilization may be employed over an unnecessarily long period, thereby increasing atrophy of bone and soft tissue. (3) Medicolegal testimony in which the age of a fracture is estimated by the absence of external callus only may be fallacious.

The authors reviewed the films of 72 selected cases in which healing took place without external callus. They found that the first roentgen sign of healing was an increase in the density of the fracture line accompanied by a decrease in the sharpness of definition of the fracture margins. This change could be detected after an average of four weeks, which is later than the average appearance of visible external callus. Further healing, following the initial increase in density, consisted of a gradual obliteration of the fracture line without formation of new trabeculae to join those of the adjacent fragments. There is marked variation in the time required for this process, ranging from eight weeks to eight months. The degree of separation of the fragments plays a very important role; the wider the separation the longer the time necessary for complete healing.

No conclusive explanation is given for the lack of external callus within joint capsules, although an inhibitory action has been attributed to synovial fluid.

**Mono-Osteitic Paget's Disease as a Clinical Entity: Roentgenologic Observations in 9 Cases.** J. A. Groh. *Am. J. Roentgenol.* 50: 230-243, August 1943.

Nine cases of mono-osteitic Paget's disease are presented to illustrate the localized character of the bone changes. Follow-up examinations seemed to prove that the mono-osteitic form of the disease does not change with time and become polyosteitic. The lesion is most often seen in the lumbar spine but may involve almost any bone.

This study would seem to indicate that Paget's disease may be of two distinct types: the generalized or polyosteitic form and the localized or mono-osteitic, the latter not representing an early stage of the former.

Diagnosis is dependent entirely upon roentgen examination. Two basic types of change may be seen. In one the disease is characterized by a decrease in the number of trabeculae but those that remain are coarser, thicker, and softer than normal. Bones of this type tend to undergo bowing or collapse as a result of weight-bearing because of their increased softness. In the other type of Paget's disease there is a generalized and extreme density throughout the involved bone. In



the spine this appearance is that of an "ivory vertebra," and the vertebrae withstand weight-bearing without collapse.

L. W. PAUL, M.D.

**March Fractures of the Lower Extremity. Report of a Case of March Fracture of a Cuneiform Bone.** H. M. Childress. *War Medicine*. 4: 152-160, August 1943.

The author reviews the literature on march fracture and reports a case involving a cuneiform bone, in a soldier. This is the first instance of solitary march fracture of the cuneiform bone to be reported.

**Dupuytren's Contracture as a Sequel to Coronary Artery Disease and Myocardial Infarction.** Kenneth C. Kehl. *Ann. Int. Med.* 19: 213-223, August 1943.

Six cases of Dupuytren's contracture occurring as a sequel to coronary occlusion are recorded here. From a review of these cases, it appears that coronary occlusion acts in some obscure manner as the precipitating factor. Changes in the palms had not been noted in any instance before the onset of cardiac difficulty.

The palmar changes appear typical of Dupuytren's contracture. A firm nodule in the palmar aponeurosis, most often in the ulnar area near the metacarpophalangeal joint is the first finding. The process is slowly progressive, gradually extending to involve the entire palmar fascia but allowing the tendons to escape. The consequent fibrosis, contracture of underlying fascia, and loss of subcutaneous fat cause the skin to appear thickened, hard, and closely adherent. Frequently the contracture becomes bilateral. Permanent flexion of one or more fingers occurs in the advanced stages. No evidence of regression was noted in any of these six reported cases. In five instances, other symptoms and signs were referable to the hands: pain, stiffness, swelling, livid discoloration, numbness, tingling, and coldness.

The relation of the time of the coronary incident to the onset of palmar changes was variable. In four cases, the interval varied from three to eleven months. In two it could not be determined.

No history was obtained in any of the cases to support the theory of an hereditary factor. In three instances, the occupation was such as to eliminate the consideration of trauma.

It is now generally believed that irritation of the sympathetic ganglia precipitates peripheral dystrophies. The associated paresthesias and color changes in the author's series indicate that the sympathetic nervous system plays a role. Attention is called to the close association of Raynaud's disease and Dupuytren's contracture.

STEPHEN N. TAGER, M.D.

## GYNECOLOGY AND OBSTETRICS

**Roentgen Pelvimetry: A Commentary.** H. Thoms. *Surg., Gynec. & Obst.* 77: 153-156, August 1943.

The author recommends routine roentgen pelvic surveys of all primigravid women to demonstrate the presence of anomalies and variations, furnish data for accurate measurements of the pelvic canal, and as a means of study of the pelvic contours. Such a survey, if made a part of the prenatal record, would furnish an accumulation of data for further study of the subject of pelvic variations. The responsibility for interpreting

the films belongs definitely to the obstetrician; sufficient data have already accumulated to furnish him with knowledge sufficient to evaluate the findings properly.

Two standard views should be taken at a distance of 36 inches—a view of the pelvic inlet and a lateral view. The inlet view is obtained with the patient in a semi-recumbent attitude with a back rest, the target being centered 6 cm. posterior to the upper border of the symphysis. To keep the inlet parallel to the film the vertical distance from table top to a point 1.5 cm. below the upper border of the symphysis anteriorly is made equal to the vertical distance from table top to the interspace between the 4th and 5th lumbar vertebrae posteriorly. The lateral view is made with the patient standing, the target being centered on the upper edge of the acetabulum. The scale of an isometric rule is projected on each film for correction of distortion, a second exposure being necessary in the inlet view. These two exposures permit two-dimensional study of all significant portions of the pelvis. Pelvic outlet films are omitted because direct measurements and contour study by palpation are easy and adequate.

The cost of the survey is relatively low, 20 minutes of time and one 8 × 10 and one 11 × 14 film being sufficient.

In the experience of the author routine pelvimetry has definitely reduced the incidence of operative interference and of forceps and manipulation in deliveries. By furnishing forehand knowledge of available pelvic space, it has placed all operative procedures on a sounder basis.

DE WAYNE TOWNSEND, M.D.

**Value of Pelviradiography in the Management of Dystocia.** Arthur Weinberg and Samuel J. Scadron. *Am. J. Obst. & Gynec.* 46: 245-254, August 1943.

The authors introduce their study of pelviradiography in the management of dystocia by reference to a series of 350 consecutive cases studied between 1936 and 1938, in which roentgen pelvimetry (10 days before term) was shown to be definitely superior to clinical pelvimetry—an accuracy of 84.1 per cent being attained in the diagnosis of contracted pelvis and 97.0 per cent in the estimation of ample pelvis.

The series furnishing the basis of the present study numbered 280 cases, in all of which there was some reason to fear dystocia. Pelviradiography was done at term or early in labor by a combined technic, including the best features of various methods of roentgen pelvimetry, pelvicephalometry, and determination of the pelvic architecture. This procedure calls for five films.

"An anteroposterior film is studied for presentation, position, number, attitude, size, and maturity of the fetus. The interspinous diameter and the circumference of the skull are measured. On the lateral view the anteroposterior diameter of the inlet and circumference of the skull are measured. These four measurements are corrected for distortion and converted into volumetric equivalents for comparison by the Ball nomogram. In addition, the true conjugate, posterior sagittal of the midpelvis and outlet, pubotuberous diameter, and depth of the pelvic axis are determined by the Thoms isometric scale.

"A pair of stereoscopic pelvic inlet films are taken with the lumbosacral angle raised, and studied in the precision stereoscope built by Dr. Myron Schwarzschild, for the determination of pelvic architecture, fetal



pelvic relationships, and to check the anteroposterior and greatest transverse diameter of the inlet measurements. A 45-degree angle anteroposterior film is taken for the study of the subpubic angle, side walls, sacrum, and ischial spines."

The cases were classified in four groups—no disproportion, borderline, relative, and absolute disproportion—and the outlook was good, fair, guarded, and poor, respectively. The radiologic prognosis proved to be correct in 97.8 per cent of the cases. Its conservative influence is demonstrated by the fact that only 114 or 40 per cent of the patients required operative delivery. The percentage of stillbirths in the series was 5.3 per cent, but the authors believe this would have been decreased by half if the radiologist's advice had been followed in every instance.

Android and platypelloid pelvises were frequently found among the cases in which a poor prognosis was given. The anthropoid pelvises were all given a favorable prognosis, and subsequent events proved this confidence justified. The gynecoid pelvis was the most difficult to evaluate correctly and the size of the pelvis was often the chief guide. There was an increase in operative deliveries in the following order: anthropoid, gynecoid, platypelloid, and android.

#### Precision Method of Cephalometry and Pelvimetry. Paul Cave. *Brit. M. J.* 2: 196–198, Aug. 14, 1943.

The author introduces a new method of determining the diameter of a given structure by x-ray which in several respects is simpler and less expensive than most procedures now employed in pelvimetry and cephalometry. The principle involved is based on the variations in size of images of the same body projected onto an x-ray film at two different distances. The technic calls for film-target distances of 60 and 30 inches, respectively. The exposures should be made on different films for clarity of detail. The data employed in each case consist of the two focal distances, the sizes of the respective images on the films, and the distance of the object—fetal head or maternal pelvis—from the film, this last being determined by triangulation, as is the fetal or pelvic diameter. Calculations are based on two formulae presented by the author.

It is stated that this form of pelvimetry requires no formal accessory apparatus and that the position of the patient on the table may vary in each case without altering the accuracy of the measurement. The same method may be used to compute the size of masses encountered outside of the field of obstetrics.

Q. B. CORAY, M.D.

### THE GENITO-URINARY TRACT

#### Some Radiologic Findings and Anatomic-Pathological Results of Experimental Renal Trauma. Armando Trabucco. *J. Urol.* 49: 601–617, May 1943.

In an experimental study of renal trauma in dogs, kidney injury was produced, under ether anesthesia, by direct contusion, firearms, and direct sectioning of the kidney with a knife. In some of the animals, following injury produced by contusion and firearms, no attempt was made to repair the injured kidney; in others the kidney was repaired with all the resources in actual use. Following the third type of trauma, the kidney was sometimes not sutured, in spite of hemorrhage; at other times it was repaired by one of the usual

methods—direct or subcapsular repair, interposition of fat or muscle, or simple suturing.

Roentgenograms were made immediately after traumatism was produced (or at most an hour later) and thereafter at intervals of 24 hours, 48 hours, a few days, and several months. Comparison was made with the opposite, untraumatized side. Excretory radiography was done with pielofanina, uroselectan, and perabrodil.

From his observations, the author concludes:

(1) When the roentgenogram is taken immediately after the injury, elimination of the opaque substance is assured. Urograms taken on subsequent days show diminution of the shadow by degrees, with a maximum diminution from the fifteenth to the thirtieth day after traumatism. Thereafter, the kidney may gradually recover normal or relatively normal function, especially when it has not been extensively injured or become infected, or there may be absolute lack of elimination of the opaque substance due to replacement of the greater part of the renal parenchyma by scar tissue.

(2) When trauma has not affected the capsule, the kidney will usually be found in its right position. When injury is very severe, however, roentgenograms taken at a distance are unsatisfactory, no shadow of the kidney being observed at all in some cases. Preservation of the capsule proper is of great importance in maintaining the shape of the organ and is essential for observation of the nephrogram within the kidney outline. When the capsule is ruptured through crushing or incision, the opaque substance may filter out of the urinary tract, and there will then be seen a marked extravasation of the liquid in the lumbar fossa on the side corresponding to the injured kidney.

(3) When trauma is not severe, operative interference is not advisable. When surgical intervention is required, extirpation of the injured organ is preferable to repair, since this latter procedure will eventually result in sclerosis.

(4) The most serious injuries are those caused by firearms, especially lead bullets.

The anatomic-pathological observations following renal trauma are more briefly reported. The lesions produced are classified as "proximity" lesions, glomerular, tubular, vascular, and interstitial lesions.

#### Ureteral Ectopia: Report of a Rare Case of Ectopic Ureter Opening in the Uterus and a Review of the Literature. Benjamin S. Abeshouse. *Urol. & Cutan. Rev.* 47: 447–465, August 1943.

Ectopic ureter opening into the uterus is a rare anomaly, only 5 cases with adequate details, including the author's, having been reported in the literature. It may be the result of (a) a severe developmental upset, with an early abnormal fusion of the wolffian duct with the müllerian ducts, or (b) the opening of the ureter into Gartner's duct, the persistent remnant of the wolffian duct in the female, which subsequently becomes dilated and finally ruptures into the cervix or vagina. The former variety is accompanied by other severe abnormalities in the genito-urinary tract and is usually incompatible with life, as it occurs in non-viable fetuses, monstrosities, or in children who die in early infancy. The latter variety explains the type of clinical case seen in the young or adult female.

In the female the outstanding symptom of ectopic ureter is urinary incontinence, present from birth. It is both diurnal and nocturnal; it is independent of

normal periodic acts of urination and bears no relation to posture. In the male incontinence is absent because the ectopic orifice is invariably above the external urinary sphincter, and the predominant symptoms are those of urinary infection.

The diagnosis of ureteral ectopia depends upon a carefully taken history, thorough physical examination, especially of the genitalia, cystoscopy, retrograde and intravenous pyelography, and excretory dye tests. Treatment is surgical, the type of surgery depending on the location of the ectopic orifice, the pathological condition of the ectopic ureter and its renal component, and the type of kidney, *i.e.*, normal kidney, double kidney, horseshoe kidney, congenital solitary kidney. The chief aim is to eliminate the incontinence or infection. Radical surgery is indicated in the presence of dilatation and infection in the ectopic ureter and its renal segment.

The author reports a case in a female thirteen months old. Autopsy revealed an ectopic ureter opening into the uterus, a sigmoid kidney, and a vesicovaginal fistula.

A thorough review of the embryological development of the genito-urinary system is included.

MAURICE D. SACHS, M.D.

**Urethrograms in Urethral Strictures: Valuable Aid in Determining Type of Treatment.** George C. Prather. *J. Urol.* 49: 482-487, March 1943.

Urethrography has been found by the author to be of great value in the study of urethral strictures. Opinions differ as to whether a watery solution or an oily substance should be used for this procedure. The author has used only lipiodol or iodochloral for the urethral injections, warming the fluid slightly to give the correct viscosity. Excellent films have been obtained and no complications have occurred.

Slow but constant injection during the time of the x-ray exposure to insure filling of the whole urethra is necessary for satisfactory films. A 20-c.c. or 30-c.c. glass syringe with a rubber acorn-type urethral tip is used, the medium being injected manually without manometric pressure control. Brodny has devised an instrument which, when attached to the syringe mentioned above, prevents x-ray exposure of the injector's hand and inhibits leakage of oil externally between the acorn tip and external meatus. To avoid skin damage to the operator's hand, this attachment should be used.

Both anterior-posterior and oblique positions are recommended for the study of urethral strictures.

The diagnosis of stricture can usually be made by calibration of the urethra with instruments, but this fails to demonstrate the exact position of the stricture if located toward the deep bulbous or membranous urethra, the length of the strictured area, any associated urethral lesions, or the anatomical condition of the urethra proximal to the stricture. With urethrography it should be possible to locate the stricture precisely, determine its length and approximate caliber, discover associated pathological changes, and indirectly visualize the urethra proximal to the area of obstruction. With this information, a decision can be reached as to whether to proceed or continue with dilatation, attempt internal urethrotomy, prepare for external urethrotomy, or use a combined suprapubic and perineal approach.

Numerous urethrograms are presented, showing both

the traumatic and inflammatory types of stricture and demonstrating various degrees of obstruction.

**Retrograde Seminal Vesiculography.** Fernan Gonzales-Iman. *J. Urol.* 49: 618-627, May 1943.

The symptoms of seminal vesiculitis are difficult to differentiate from those produced by prostatic, epididymal, or renal conditions. Diagnosis is based upon (1) the history of symptoms, (2) physical examination—particularly rectal palpation—and (3) seminal vesiculography.

Preliminary preparation for vesiculography consists in dilatation of the urethra with sounds to the maximal capacity, prostatic massage, and application of phenol-glycerine (50 per cent) to the posterior urethra through the urethroscope. "Urethroscopy is greatly facilitated by use of the Peterson holder. After localization of the base of the verumontanum, the holder is fixed in position, keeping the instrument steady; the water is stopped; the telescope removed, and the remaining water in the sheath of the instrument is aspirated and phenol-glycerine applied with a cotton applicator. Some water is run in, and, by closure of the upper end of the sheath, the remaining phenol is washed into the bladder . . . . After a few urethroscopic treatments—varying from 2 to 6—the urethra is usually fairly clear and ready for vesiculography."

Retrograde vesiculography, when preceded by the above described preparation of the urethra, is successful in 98 out of 100 cases. The technic of catheterization of the ejaculatory ducts is very important. The catheter must follow the anatomical contours of the ducts. A gold tip, attached to the ordinary woven silk catheter (devised by Peterson), is employed routinely. "The curved tip of the catheter in a few seconds can be introduced several millimeters into the ejaculatory duct by twisting the catheter and simultaneously rotating the telescope. The holder is then loosened and the urethroscope elevated to a 40 to 60-degree angle, as required. Under direct vision, the tip of the catheter is directed downward and inward into the ejaculatory duct; then, by slow twisting and gentle pushing, the tip is directed downward and outward. When properly engaged in the ejaculatory duct, it passes outward with ease when no inflammation or stricture is present . . . . When the catheter is in place 1 to 3 c.c. of diodrast (35 per cent) is injected slowly with an ordinary syringe."

With vesiculography, the different types of vesiculitis—catarrhal, interstitial, and mixed—can be differentiated.

The author quotes Peterson's description of the pathological types of vesicles, as delineated by the vesiculogram (*J. Urol.* 39: 662, 1938).

(1) *Catarrhal type.* In early cases, the gland is distended with purulent or mucopurulent material, reducing the vesico-ampullar space; a certain number of convolutions may remain preserved. In the intermediate form there is dilatation of the distal half with the terminal portion raised to or above the level of the vas. In the late stage, there is dilatation of the entire gland and straightening of the convolutions, causing the gland to resemble a tortuous hydroureter.

(2) *Interstitial type.* In the early stage there are a few circular or spiral convolutions, with localized distention and beginning obliteration of the lumina. In the intermediate stage there are narrow tubular shadows with shallow, wavy convolutions; in the late

stage, a few irregular cavities which may appear to be completely detached.

(3) Partial dilatation of a typical interstitial gland, with stricture or angulation of the ejaculatory or seminal duct, causing distention, is usually seen.

A number of vesiculograms are reproduced.

## VENOGRAPHY

**Venography of Lower Extremity: A New Technic—Preliminary Report.** Emile Zax. *Am. J. Surg.* 59: 551-553, March 1943.

A venogram taken to demonstrate the deep veins of a normal extremity unexpectedly showed what might be interpreted as a blockage of the popliteo-femoral vein. The most likely explanation was that in this case there was less resistance to the flow of the injected solution in the great saphenous than in the small saphenous vein, causing the solution to go into the saphena magna through the communicating veins of the distal leg. To obviate such an occurrence when deep vein blockage is suspected and also to do away with the necessity of cutting down on the small saphenous vein, the author devised an apparatus to be placed at the knee, consisting of two blocks of wood, each  $6 \times 6 \times 0.5$  in., well padded with felt and connected by two iron bars 8 in. in length and threaded for 3 in. at each end. This is slipped over the leg until the anterior bar is at the midpatella region and then tightened, compressing the great saphenous vein at the medial side of the knee but not the small saphenous vein in the popliteal area. Diodrast injected in any vein of the foot or ankle region should have to pass this area by going through the deep veins or the small saphenous vein. If the deep vein should be blocked due to a pathological process, a detour around the compressed area of the saphena magna or a failure of the dye to go farther should be expected.

**Thrombosis of the Subclavian and Axillary Veins. Report of 46 Cases.** James R. Veal and Hugh H. Hussey. *Am. Heart J.* 25: 355-369, March 1943.

The data obtained from a study of 46 cases of thrombosis of the subclavian and axillary veins, observed by the authors during the past five years, are presented. In 16 cases the thrombosis occurred as a complication of heart failure, in 10 it was the result of effort or trauma, in 18 it was secondary to neoplasm, and in 2 it resulted from scar formation in the axilla. The authors discuss the general symptomatology and point out the variations peculiar to each of the main etiologic groups. The importance of measuring the venous pressure locally during exercise of the hand, as well as at rest, is emphasized. Venography is considered to be

of value in confirming the diagnosis and ascertaining the location of the venous obstruction and the extent of collateral circulation. Suggestions for treatment are also given.

**An Apparent Causal Mechanism of Primary Thrombosis of the Axillary and Subclavian Veins.** John J. Sampson. *Am. Heart J.* 25: 313-327, March 1943.

Thrombosis of the axillary and subclavian veins may be caused by infection of regions adjacent to, or drained by, these veins, by invasion or compression by neoplastic tissue, by direct external trauma, or by some unknown mechanism related to forceful or sustained motion of the shoulder girdle or arm on the affected side. The diagnostic term, primary or effort thrombosis, is applied to the cases that fall into the last group.

The types of precipitating effort are classified by the author as follows: (1) no unusual effort or motion, (2) lifting of heavy weights, (3) long sustained and moderately vigorous activity involving the arm or arms and shoulder girdle, (4) minimal effort involving frequent or sustained elevation of the arms over the head.

The author presents five cases of primary thrombosis of the axillary and subclavian veins: one case is classified as Type 1, one as Type 2, two as Type 3, and one as Type 1 or 3.

The various hypotheses concerning the pathogenesis of primary thrombosis are summarized. The author refers to a previous paper (Sampson, Saunders, and Capp: *Am. Heart J.* 19: 292, 1940), in which the theory is presented that compression of the subclavian vein, resulting in thrombosis, often may be caused by a posterior and cephalad rotation of the clavicle that narrows the space between the subclavius muscle and the superior margin of the inner third of the first rib through which the vein passes. This position of the clavicles may result from upward or backward motion of the shoulder girdle without abduction of the arm. Roentgenograms in two cases, taken with the aid of a diodrast solution, are presented to confirm this hypothesis.

The possibility should be considered, the author believes, that the disease in all four classifications of activity may have resulted from a predisposing anatomic configuration of the clavicles and first ribs—posteriorly directed clavicles and broad, horizontally curving ribs. Hypertrophy of the subclavius muscles may be a contributing factor. In two of the cases reported the characteristic rib and clavicle relations were demonstrated by physical examination and roentgenographic studies. The chest roentgenograms were taken in the routine manner, having the patient extend his arms forward around the cassette, which tends to throw the shoulders forward.

## RADIOTHERAPY

### MALIGNANT NEOPLASMS

**Trauma and Malignancy.** William J. Carson. *Am. J. Surg.* 59: 420-428, February 1943.

The author reviews the literature on the relationship of trauma to malignant lesions and reports two cases of sarcoma which fulfill the postulate of Segond (*Assoc. franç. d. chir.* 20: 745, 1907) as due to single trauma.

One patient, a woman aged 64, severely injured her

right hand and forearm in a washing machine wringer. A few months later a tumor appeared on the back of the right wrist. This was excised and diagnosed histologically as fibrosarcoma. The patient received six x-ray treatments, followed by radical excision and further x-ray therapy. Upon recurrence of the tumor, the arm was amputated 3 cm. above the epicondylus lateralis humeri and deep x-ray therapy was given. Death occurred approximately two years after the in-

jury. The anatomical diagnosis was fibrosarcoma of the right forearm with metastasis to the right axilla, pleura (bilateral), and hilar lymph nodes.

The second patient, a man of 60, struck his right femur against a fire hydrant. Three years afterward roentgen examination showed a tumor of the lower end of the bone. Biopsy led to a diagnosis of fibrosarcoma. A hip joint disarticulation was performed. Deep x-ray therapy was refused. At the time of the report, there was no evidence of recurrence.

**The "Malignant" Hemangioma.** Louis T. Byars. Surg., Gynec. & Obst. 77: 193-198, August 1943.

Hemangiomas may vary in severity from small reddish blotches and port-wine stains to venous engorgements and arterial angiomata which tend to grow and invade local tissues. Spontaneous cure is not to be expected, but growth of the benign types is usually slow. The arterial hemangioma, because of its tendency to grow, invade, and destroy, may be considered as "malignant" in type, and its occasional rapidity of growth, coupled with destruction of vital parts and deformity of features, makes early and active treatment necessary.

The *port-wine stain* involves the entire thickness of the skin, and grows only as the child grows. Radiation is usually ineffective, and adequate treatment consists of replacement of the involved skin throughout its whole depth. It is often best to recommend the use of cosmetics rather than more radical measures.

The *venous angioma* is slow in growth. It consists of large channels filled with venous blood. Treatment is surgical, by excision or by multiple injections of a sclerosing solution. Occasionally the interstitial use of radon is helpful.

The *arterial angioma* may be treated by excision or, if small, by destruction with the cautery. If the lesions are spotty and limited to the skin, satisfactory results may be secured by freezing with carbon dioxide ice. In cases involving the subcutaneous tissue as well as the skin, if the lesion is relatively shallow, the author suggests that the use of surface radium radiation may prove satisfactory. Recurrences are most often found around the supplying arteries of the deeper extensions, and these deeper areas, which need the most intense treatment, get the least from surface irradiation. In such cases the surface may be damaged by radiation which is, nevertheless, inadequate to control the lesions in the depths. In these more malignant arterial angiomata, interstitial implantation of radon seeds is most effective. In cases where size and location of the growth make surgical removal impossible or inadvisable, interstitial irradiation is the method of choice. Deep extensions of the growth can be eradicated in this way with minimal injury to adjacent structures.

The author's technic includes the use of hollow needles fitted with a plunger, for introducing and placing the tiny seeds in the tissues. Adequate and equal radiation to all parts of the growth is desirable, including the deep ramifications. The seeds are placed so that one cubic centimeter is affected by each or, if the eyelid is involved, one per square centimeter. They must be placed at a safe depth from the surface of the skin or mucous membrane, from the lens or cornea, and from growing points of bone or cartilage. The dosage for arterial hemangiomas, if near the eyes or nose, is usually 0.25 millicurie per seed; but when delicate organs are not involved and there is greater volume of

growth, 0.50 millicurie per seed is desirable. It is advisable to undertreat rather than overtreat an area; a second application can be made later if advisable.

Complications to be considered include (a) ulceration of the tumor, which may occur even in untreated cases; (b) infected thrombi; (c) secondary deformity, usually caused by overdosage; (d) recurrence, which may call for reapplication of seeds, surface irradiation, or excision; (e) an occasional poor appearance, such as a deformed feature or area of baldness, which may require surgical repair. The gold seeds themselves are left *in situ* unless close to the skin surface where they may be visible.

The time of response is usually one week, followed by speedy recession of the growth for two weeks longer, and after this a slow, progressive improvement extending over six months to a year. Photographs of lesions are included. DE WAYNE TOWNSEND, M.D.

**Good Result in Radium Treatment of an Extensive Cavernous Hemangioma.** W. Lutz. Schweiz. med. Wchnschr. 73: 902-903, July 17, 1943.

A child born March 28, 1936, was seen the following November because of an extensive cavernous hemangioma involving the right neck and cheek and the entire lower lip. Since surgery was impractical, irradiation was undertaken. Two radium plaques were used; one was square, 3 cm. in length, and contained 34.8 mg. of radium (3.8 mg. per sq. cm.); the other was round, 1.8 cm. in diameter, and contained 18.7 mg. of radium (7.2 mg. per sq. cm.). Four treatment series were given:

(1) Nov. 6-10, 1936: Four areas on cheek and neck were treated with the square and 5 with the round applicator; 1 area on the lip with each applicator.

(2) Feb. 9-10, 1937: Four areas on cheek and neck treated with the square, 3 with the round applicator; 1 area on the lip with the square applicator.

(3) May 10-12, 1937: Six areas on face and neck treated with the square, 8 with the round applicator; 1 area on lower lip with square applicator.

(4) Sept. 23-24, 1937: Five areas on cheek and neck treated with square, 2 with round applicator; 3 areas on lower lip with round applicator.

The treatment time for each area was from two to two and a half hours; at no time was any reaction observed.

Observation on June 11, 1938, showed excellent regression but slight skin atrophy and some telangiectasia. The author feels that the use of smaller doses and wider spacing of doses might have led to an even better result.

LEWIS G. JACOBS, M.D.

**Roentgen Rays in the Treatment of Malignant Tumors of the Kidney in Adults.** H. Dabney Kerr and Robert L. Stephens. Am. J. Roentgenol. 50: 204-206, August 1943.

The results of roentgen treatment in 37 adult patients with malignant tumors of the kidney, treated during the ten-year period between 1927 and 1937, are reported. All patients were traced and those now living have been observed from 60 to 120 months. Of the 12 surviving patients (31.6 per cent of the total), 8 had preoperative roentgen irradiation. The remainder received irradiation after nephrectomy or roentgen therapy alone. While the number of cases is small, it appears that in those that are operable, preoperative roentgen therapy improves the prognosis while post-operative therapy apparently has nothing more to

## RADIATION REACTIONS

**Treatment of Post-Irradiation Erythema with Chlorophyll Ointment.** George W. Holmes and H. Peter Mueller. *Am. J. Roentgenol.* 50: 210-213, August 1943.

Chlorophyll, the green coloring matter in plants, has been found to be useful in the treatment of chronic ulcers, especially those of the indolent varicose type. The authors report the use of chlorophyll in the treatment of erythemas following irradiation. The chlorophyll was used either in the form of ointment or oil in a 3.0 per cent concentration with a lanolin base for the ointment and peach kernel oil for the oil. The addition of 1.0 per cent nupercaine to the ointment eliminated the momentary tingling sensation and burning which some patients noticed, following its first appli-

cation. A formula and the method of preparing the ointment are given.

As compared with vaseline or boric acid ointment, results following the use of chlorophyll appeared to be quite remarkable. Within a few days a distinct change was noticeable; the erythematous area was cleaner; the crusting had disappeared; and granulation appeared where the skin had been denuded. When infection had been present before the application of chlorophyll, it disappeared. The patient felt more comfortable. The treatment of long-standing irradiation ulcers was less satisfactory. In a few instances distinct improvement occurred, but in general the effects in such cases were disappointing.

L. W. PAUL, M.D.

## PROTECTION

**Ventilation Requirements for Radium Dial Painters.** W. C. L. Hemeon and Robley D. Evans. *J. Indust. Hyg. & Toxicol.* 24: 116-120, May 1942.

**Prevention and Control of Hazards in the Radium Dial Painting Industry.** L. F. Curtiss. *Ibid.* 24: 131-141, June 1942.

**Storage of Radium Dial Instruments.** Charles R. Williams and Robley D. Evans. *Ibid.* 24: 236-237, October 1942.

**Protection of Radium Dial Workers and Radiologists from Injury by Radium.** Robley D. Evans. *Ibid.* 25: 253-269, September 1943.

**Protection of Radium Dial Painters—Specific Work Habits and Equipment.** George E. Morris, Irving R. Tabershaw, John B. Skinner, and Manfred Bowditch. *Ibid.* 25: 270-274, September 1943.

The papers listed above have to do with the precautions to be observed in radium dial painting. As is pointed out by Hemeon and Evans, this is a matter of especial importance because of the recent unprecedented demand for luminous dials for aircraft instruments and other machines of war. Their recommendations are as follows:

1. Radium dial painting shall take place in booths through which air is exhausted at a rate of 50 cfm.

2. Cabinets in which dials are stored or dried shall be ventilated as follows: (a) not less than 360 cubic feet of air per minute per 1,000 dials stored, continuously, or (b) not less than that sufficient to induce an average face velocity of 75 linear fpm through the area of the doorway when doors are opened.

3. Radium-painted dials shall at all times be so located that the radon formed is withdrawn by local exhaust or diluted to safe concentration.

4. Containers of radium paint that have been sealed for several hours shall be opened only when inside a hood or ventilated cabinet.

Curtiss classifies the preventive measures required to control injuries which may be caused by radium in dial painting into three groups, corresponding to the manner in which the radium is introduced into the body and produces its effect.

- (1) *Ingestion* must not occur. This took place in the early days of the industry, when the painters, ignorant of the possibility of poisoning, pointed the brushes between their lips. This practice has been abolished. Accidental ingestion through carelessness and untidiness must, however, still be carefully guarded against. An ultraviolet light is helpful in maintaining cleanliness in dealing with radium paint, as it causes small deposits of radium paint on clothing or hands to fluoresce brightly.

- (2) The best remedy for *inhalation* of radon or radioactive dust is sufficient and well designed ventilation.

- (3) To protect workers from *gamma rays*, any large accumulations of radioactive material, such as stocks of luminous pigment or completed work, should be stored at a sufficient distance from the work. Methods used to ascertain whether any particular arrangement is safe (measurement of ionization produced by radon in equilibrium with the radium and the ionization by gamma rays) are described by the author.

In the article by Williams and Evans, the precautions which should be observed in the storage of finished instruments are given.

Evans' paper on the protection of radium dial workers and radiologists discusses the three distinct industrial hazards in the handling of radium and radium products: (a) radium poisoning, from ingestion or inhalation of radium, (b) respiratory lesions from inhaled radon, and (c) radiation injury from over-exposure to gamma rays. The tolerance values are respectively: (a) 0.1 micrograms of radium in the body or 1 micromicrocurie of radon per liter of exhaled breath, (b) 10 micromicrocuries of radon per liter of inhaled air, and (c) 3 roentgens of gamma radiation per month, over the entire body. A method for determining the radon content of the breath is given. Precautionary measures which should be taken for the protection of the radium worker are outlined.

Morris, Tabershaw, Skinner, and Bowditch make suggestions regarding work habits and equipment for the protection of radium dial painters.

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# RADIOLOGY

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## Kidney Tumors

Classification, Review of Symptoms, Methods of Diagnosis, Therapy, and End-Results<sup>1</sup>

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NEOPLASMS ARISING in the kidney cortex may not cause hematuria until they break into the renal pelvis; they are not apt to produce pain until they invade the capsule; patients seldom notice the kidney mass themselves, and as a result the tumor has, in most instances, grown to large proportions before recognition. These so-called "nephromata" tend to erode venous channels and thus metastasize widely. By the time the lesion is recognized the tumor is large, it has often metastasized, and as a result the prognosis is most unfavorable.

### CLASSIFICATION

According to Boyd (1a), "there is no more perplexing chapter in the whole of pathology than that which deals with tumors of the kidney." The influence of Grawitz (2) is still felt, in that all cortical tumors except the embryoma are apt to be roughly construed as hypernephroma. On the other hand, there are those who deny the existence of a true hypernephroma, *i.e.*, a tumor arising from misplaced islands of adrenal tissue, as Carson (3), Judd and Hand (4). These writers state that hypernephroma should be considered as a true renal carcinoma. Arguments

against the adrenal origin of this tumor have been listed as follows:

- (a) No epinephrin has been synthesized from these growths.—Greer and Wells (5), Brooks (6).
- (b) Double-refracting fat present in hypernephroma is present, also, in the protoplasm of renal epithelium and carcinoma.—Löhlein (7).
- (c) Tumors of the adrenal may produce abnormalities of the sexual organs, as virilism. Such changes have never been noted with hypernephroma.—Tuffier (8), Ewing (9a), Boyd (1b).
- (d) The hypernephroma is composed of lipid-filled cells which have the usual vacuolated appearance following routine preparation in alcohol and xylol. According to the Grawitzian school, these cells closely simulate those in the adrenal cortex, but identical cells are found in adenomata of the kidney. Furthermore, the hypernephromata may take on tubular formation, which is never present in the adrenal.—Boyd (1b).

Portmann (10), on the other hand, definitely assumes the presence of hypernephroma. He states: "It originates from an inclusion of suprarenal cortical tissue. It is often confused with carcinoma because it is inclined to deviate very consider-

<sup>1</sup> Read by title at the Twenty-ninth Annual Meeting of the Radiological Society of North America, Chicago, Ill., Dec. 1-2, 1943.



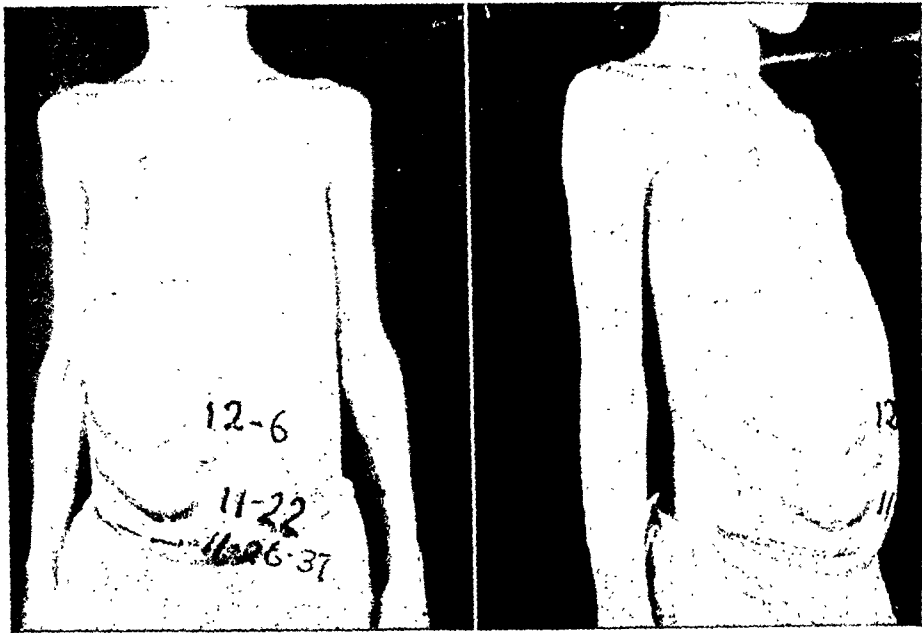


Fig. 1. Wilms' tumor: Radiosensitivity. This tumor shrank as shown by the lower and upper skin markings to approximately a third of its original size. X-ray therapy was begun Nov. 26, 1937. The skin marking dated Nov. 22 was made before the institution of radiotherapy.

ably in its histologic structure; however, these two groups have nothing in common from a clinical standpoint." He (Portmann) continues with the statement that the hypernephroma remains encapsulated for a long period of time and its growth is usually slow, while adenocarcinoma has a tendency to early infiltration and therefore more rapid extension. Furthermore, hypernephromata tend to erode veins and metastasize widely, while adenocarcinoma spread by lymphatic extension.

Ewing (9b) takes a more middle ground in that he agrees to the occurrence of adrenal inclusions in the kidney and to the fact that tumors may arise within these rests. He concludes however: "Finally, recent studies have demonstrated that a large proportion of reported hypernephromas are renal adenocarcinomas."

The following working classification of malignant kidney tumors is used at the Brooklyn Cancer Institute:

- 1. Tumors arising in the kidney cortex.
  - (a) Papillary adenocarcinoma.
  - (b) Alveolar adenocarcinoma.
  - (c) Adenomyosarcoma (Wilms' tumor).

- 2. Tumors arising in adrenal rests. Hypernephroma.
- 3. Tumors arising in the kidney pelvis.
  - (a) Papillary epithelioma.
  - (b) Alveolar carcinoma.

PATHOLOGY

1. *Tumors Arising in the Kidney Cortex:* (a) The *papillary adenocarcinoma* is the most common type of neoplasm arising in the kidney parenchyma. This tumor is the one most frequently confused in the literature with hypernephroma. Microscopically, there is a distinct tendency to papillomatous structure with distinct gland formation. Interstitial hemorrhage occurs frequently. According to Portmann, these neoplasms do not remain encapsulated but infiltrate rapidly through the kidney. They do not erode venous channels as frequently as does the so-called hypernephroma and therefore are more apt to metastasize by lymphatic extension.

(b) *Alveolar adenocarcinoma* is subdivided by Ewing (9c) into adenocarcinoma (i) of infants and (ii) of adults and (iii) tubular adenocarcinoma reproducing renal tubules. The embryonal carcinomas (i



Figs. 2 and 3. Wilms' tumor with metastasis to lung. On intravenous pyelography, only the lower calix filled with dye. The opacity above represents calcium in the tumor. Before death metastases appeared in the brain, cranium, and pelvic bones, as well as in the lung.

and ii) retain many of the characteristics of the Wilms' tumor except that the sarcomatous elements are lacking. All of the cases in the series recorded here actually belong to the last group (iii), namely, those reproducing renal tubules. Here the pathology is characteristic in that the formation strongly simulates that of normal kidney tubules. The cells are clear or granular, with central small, dark-staining nuclei. There is little supporting structure.

(c) The embryonal structure of *adenomyosarcoma* (Wilms' tumor) is most striking. It usually consists of distorted renal tubules, with scattered abortive glomeruli. Such areas are interspersed with zones of sarcomatous spindle cells. These latter elements may consist of voluntary or involuntary muscle. Wilms' tumor grows very rapidly and in most instances a large mass is palpable in an infant before other symptoms become manifest. The immediate response to irradiation is at times most gratifying, in that a tumor will shrink to a half or a third of its original size within a

few weeks (Fig. 1). Here again there is a tendency to early and widespread metastasis, particularly to lung and bone (Figs. 2 and 3).

2. *Tumors Arising in Adrenal Rests (Hypernephroma)*: These Grawitzian tumors are characteristic according to Ewing (9d). "They are large, well circumscribed, yellowish, fatty and vascular tumors, prone to hemorrhage, necrosis, and cyst formation." Ewing eliminates from this classification "all tumors with distinct lumina, and especially those of papillary structure." The cells appear to grow diffusely but may be arranged in "small circular groups separated by fine strands of connective tissue." Thus on the basis of the cellular characteristics alone this tumor can easily be confused with the papillary adenocarcinoma, and the author, after careful review of all the slides, is unwilling to list any of the neoplasms in his series as true hypernephroma but has placed them all under the classification adenocarcinoma. There are, however, 16 specimens that

would fit in with the above morphological grouping of hypernephroma.

3. *Tumors Arising in the Kidney Pelvis:* Tumors having their origin in the kidney pelvis represent but 7 per cent of the total number of renal tumors. Because of their location, bleeding is an early symptom and the pelvic deformity is readily recognized on the x-ray film. These pel-

rounding kidney parenchyma and are highly malignant.

#### DIAGNOSIS

The prompt recognition of the cortical kidney tumors is often difficult. These neoplasms will often remain silent for years before localizing symptoms lead to their recognition. The x-ray film usually gives the most direct evidence (Fig. 4). When the growth is situated well to the periphery, the calices will not be disturbed, and the diagnosis can be made only by a careful study of the (A) kidney outline. This surface distortion can be confirmed by perirenal air insufflation. The growth may (B) spread two adjacent calices or (C) may displace a single calyx. Braasch (12) has brought out the typical (D) elongation and hooking of the involved calix. Of course, the larger the tumor the bigger and more deformed is the kidney shadow and the more distorted the calices.

Bone metastases are usually characteristic in that they consist of massive zones of cortical and spongy bone destruction not associated with any periosteal, cancellous reaction or new bone formation. They often involve the ends of long bones, as the neck and head of the humerus. Pathological fracture is frequent and is often the earliest presenting symptom. Bone regeneration is not initiated by this fracture, as commonly occurs in the case of giant-cell tumors or metastases from mammary carcinoma. No trabeculation is present within the tumor area, nor is there expansion of the cortex, as with giant-cell tumor (Fig. 5). These metastases are rarely multiple and do not consist of concentric globular areas of destruction such as are seen in multiple myeloma.

The lung metastases are usually cottony, irregular masses present in the hilar zones or lower third of each lung field. Their location and wide distribution suggest hematogenous extension.

#### STATISTICAL REVIEW

The Brooklyn Cancer Institute was transferred to its present location in Octo-

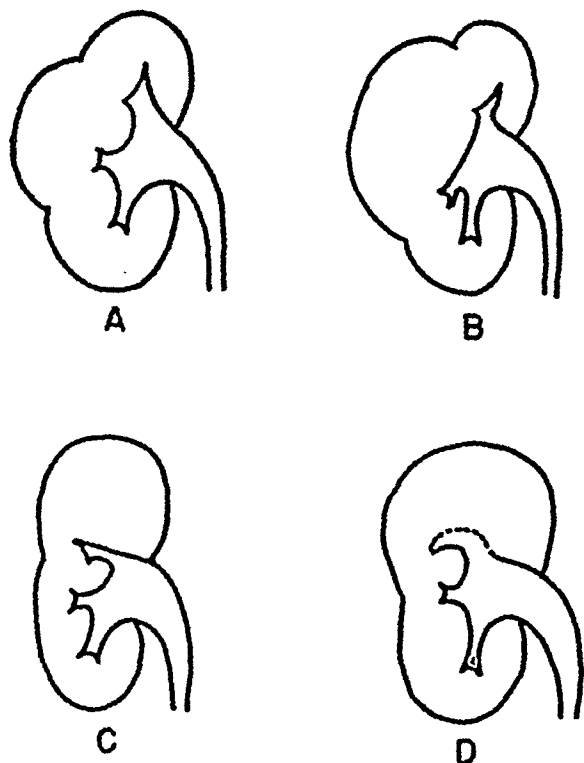


Fig. 4. Schematic drawing of renal cortical carcinoma. A. Lobular distortion of renal shadow without involvement of the calices. B. Adjacent calices are spread by growth. C. Single calix is displaced. D. Hooking and elongation of involved calix.

vic defects must be carefully differentiated from non-opaque calculi, blood clots, and disease of the calices, as tuberculosis. None of this group has been found in the records of the Brooklyn Cancer Institute.

(a) *Papillary epithelioma* arising in the renal pelvis is of very rare occurrence (Kerwin, 11). Its papillary, warty structure is characteristic. It tends to metastasize down the ureter and into the bladder.

(b) *Alveolar carcinoma* is the more common of the pelvic tumors. In the early stages these growths have a flat appearance. They infiltrate readily into the sur-

ber 1936, and not all of the earlier records are available for review. To date, 54 patients (43 since October 1936), out of a total of 6,400, have been admitted to the Brooklyn Cancer Institute with a diagnosis of a primary malignant tumor of the kidney, representing 0.65 per cent of all admissions.

Of this group of cases, 45 were proved by nephrectomy or autopsy and 9 have no pathological confirmation. In all of the latter, however, roentgen determination of kidney deformity and proof of metastases to lung were obtained, and bone metastases were demonstrable in 7 instances. Such findings are considered of sufficient weight to justify inclusion of the case in summation of end-results.

The cases with pathological confirmation (including 2 omitted from the statistical review) are classified as follows:

1. Tumors arising in the kidney parenchyma.	
(a) Papillary adenocarcinoma.....	35
(b) Alveolar adenocarcinoma.....	5
(c) Adenomyosarcoma (Wilms' tumor)...	5
2. Tumors arising in adrenal rests.	
Hypernephroma (see heading 2 under Pathology).....	0
3. Tumors arising in the kidney pelvis.	
(a) Papillary epithelioma.....	0
(b) Alveolar carcinoma.....	0
4. Embryonal tumor (not classified)*.....	1
5. Neurocytoma, perirenal†.....	1
TOTAL with pathological proof.....	47

[\* The embryonal tumor was never satisfactorily classified. At operation only a small biopsy specimen of a cyst wall was obtained. The patient died about one year later of metastasis. This case is not included in the summary because of the indefiniteness of the pathological diagnosis.

† The perirenal neurocytoma was discovered as a palpable kidney mass in a four-months-old infant (Fig. 6). On a clinical diagnosis of Wilms' tumor, preoperative x-ray therapy was given. At operation the tumor was successfully stripped from the lower pole of the kidney. To date (two years) there has been no recurrence. This case is eliminated, as the tumor did not actually arise within the kidney.]

Cases proved by x-ray film of kidney and metastases (microscopic pathology not obtained.)	9
Cases proved by nephrectomy or autopsy.....	45
TOTAL	54

We have, thus a total of 54 cases of malignant renal tumors, 45 of which are proved by gross and microscopic pathologic studies. Thirty-six patients were males and 18 females, a 2 to 1 ratio. Eliminating the 5 cases of Wilms' tumor, the oldest patient had reached his 79th year and the youngest her 9th year; the average age was 49.6 years.



Fig. 5. Metastasis to ilium from adenocarcinoma. The large wiped-out defect in the ilium was diagnosed as a giant-cell tumor, in spite of lack of trabeculations and cortical expansion. The greatly enlarged left kidney is clearly seen above.

It is well known that these cortical tumors are prone to remain symptomless for a long period of time. In 14 of this series, or approximately 1 in 4, the presenting symptom first referred to was due to the presence of a metastasis (Fig. 5).

Pain was the outstanding and the first symptom in 29 instances. Hematuria was the earliest sign in 21 cases; in 4 the first indication of trouble was the detection of an abdominal tumor. Only 11 persons in the whole group are still living, and but 5

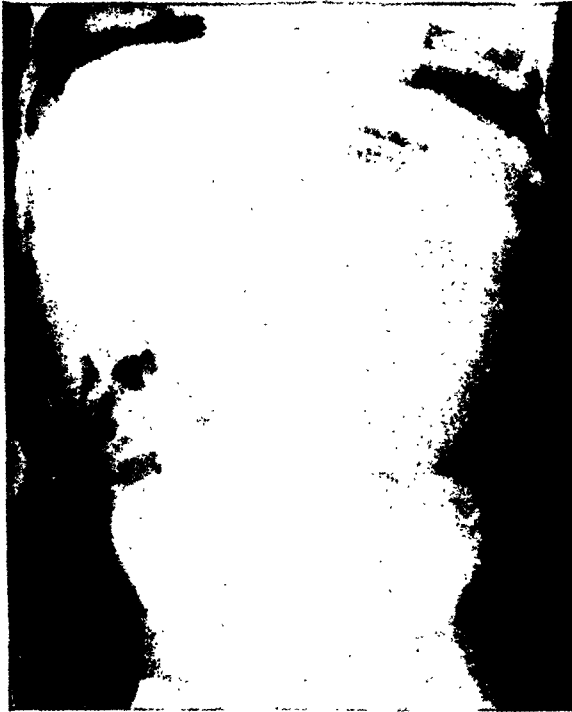


Fig. 6. Perirenal neurocytoma. The tumor is attached to the lower pole of the kidney, displacing and rotating the kidney as shown by the changed axis of the pelvis.

of these have been carried over three years without known metastases. Table I lists the cases according to year of admission, with end-result. The 11 cases with survival to date may be summarized as follows:

1. L. F., male, age 66, living seven years following nephrectomy without evidence of metastasis. Papillary adenocarcinoma.
2. L. S., female, age 12, living five years following nephrectomy, without evidence of metastasis. Papillary adenocarcinoma.
3. P. R., male, age 45, living five years after nephrectomy, without evidence of metastasis. Papillary adenocarcinoma.
4. E. B., female, age 63, living five years following nephrectomy. X-ray evidence of one metastasis to a dorsal spinous process in 1939. This has not changed in four years and therefore probably represents a bone cyst. Alveolar adenocarcinoma.
5. M. S., female, age 9, living seven months following nephrectomy and three and a half years after admission. This patient had extensive preoperative radiation therapy. Her case is described below. Adenocarcinoma. Grawitz type
6. D. L., male, age 48, living two years following admission. This is the only living patient who has not undergone nephrectomy and who is without pathological proof of neoplasm. He is included in

TABLE I: END-RESULTS IN 54 CASES OF KIDNEY TUMOR

Admission Year	Number of Cases	Nephrectomy	End-Result		Average Survival Period	
			Living	Dead	Living (months)	Dead (months)
1936 and before	11	10	1	10	84	23
1937	4	2	0	4	0	4
1938	14	9	3	11	60	12
1939	5	3	0	5	0	15
1940	5	5	1	4	42	7
1941	8	4	1	7	26	5
1942	2	2	1	1	13	7
1943	5	4	4	1	4	3
TOTALS	54	39	11	43		

this series because of demonstrated defect in a renal calix. He also has a pathological fracture of the right femoral neck.

7. K. Z., female, age 24, living one year following nephrectomy, without metastases. This patient has had postoperative radiation therapy. Wilms' tumor.

8. L. K., female, age 63, living one year following nephrectomy. She has both local recurrence and metastasis to lung. Papillary adenocarcinoma.

9. E. L., female, age 66, living 4 months following nephrectomy. She has no demonstrated metastasis. Wilms' tumor.

10. L. C., male, 42 years, living 2 months following nephrectomy. He has demonstrable metastases in the ilium and dorsal spine. Adenocarcinoma, Grawitz type.

11. F. W., male, age 7 years, living 2 months following nephrectomy. This patient received preoperative radiation therapy. No metastases have been demonstrated to date. Wilms' tumor.

Patients 1 to 5 have survived from three and a half to seven years and are the only ones to have passed the more critical interval of the first two years without evidence of metastasis. All others either have known metastases or have not survived a sufficient waiting period to be considered favorably from a prognostic point of view. In this respect, the author has had the experience, in his private practice, of seeing a recurrence of tumor twenty years after nephrectomy.

#### TREATMENT

Thirty-eight patients have undergone nephrectomy, and but 5 of these have

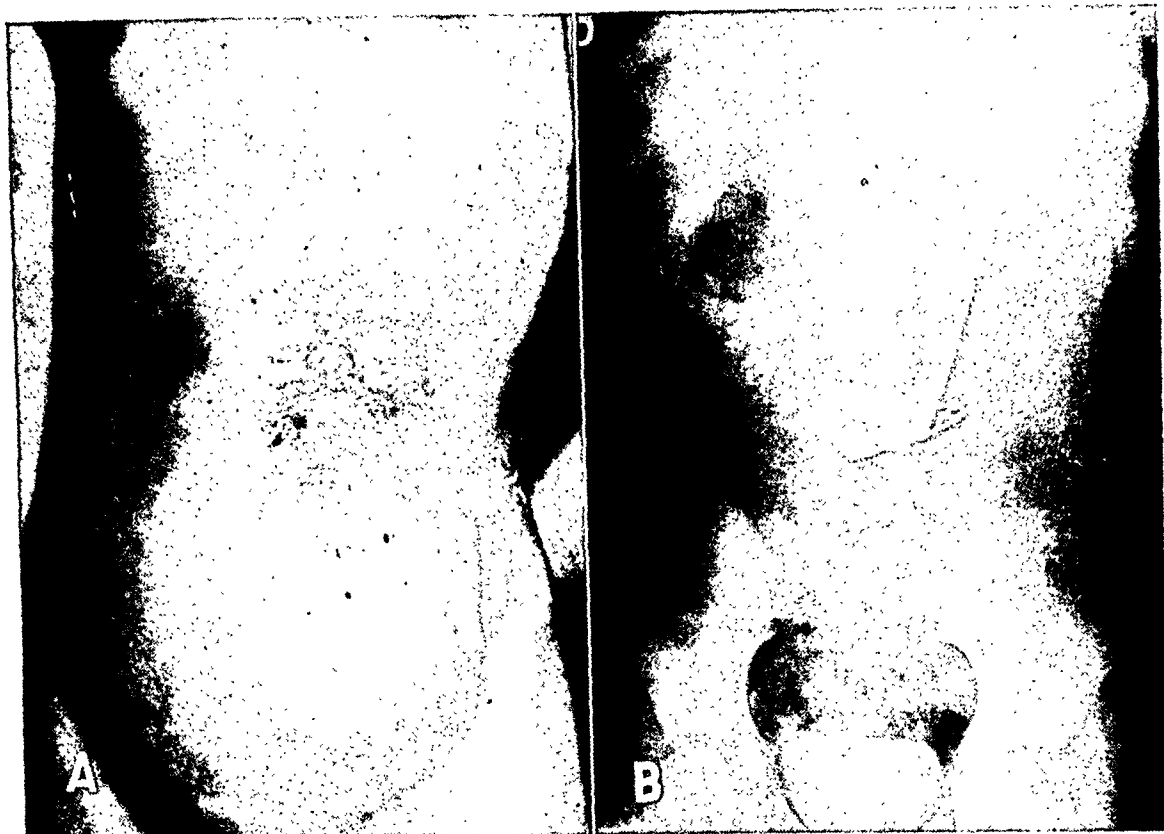


Fig. 7. Adenocarcinoma of Grawitz type (patient M. S.). A. Sinus tract draining from tumor to the anterior abdominal wall. This followed the original exploratory laparotomy. B. A rubber tube extends into the sinus tract. The kidney pelvis is displaced by the tumor in the upper pole.

survived over three years without known metastases, or 1 in 7. Four of the survivors are listed as having papillary carcinoma; the fifth alveolar carcinoma.

Many of these renal tumors are radio-sensitive and respond to x-ray therapy, as is attested by Waters (13). Prenephrectomy roentgen therapy is theoretically worth while if it will reduce the size of the tumor and so injure the neoplasm that it is unable to metastasize. Preoperative roentgen therapy was delivered in 3 instances in this series with reduction in the size of the tumor in all cases and with improvement in the clinical condition in 2. One case illustrating clinical improvement following irradiation is summarized as follows:

M. S., a thin, anemic girl of 9 years, was admitted to the Brooklyn Cancer Institute in April 1940. At laparotomy performed in another institution because of a large upper left abdominal mass "size of a watermelon," it was found that the tumor could not be removed but a biopsy was taken. Most of the biopsy specimen was badly broken down and only a few

cells could be identified as carcinoma. This operative procedure was followed by infection (Fig. 7A) and on admission to the Brooklyn Cancer Institute a sinus was present in the anterior abdominal wall through which oozed large quantities of a thick purulent material (Fig. 7B).

The upper left abdomen was cross-fired through 3 ports, 200 r being delivered to 2 areas daily, the areas being so rotated that between April 1 and May 11, 1940, an estimated 5,750 r was given to the center of the tumor. This treatment resulted in decreased discharge from the sinus, moderate reduction in the size of the mass, and improvement in the child's general condition. A second cycle of radiation was delivered between Jan. 2 and Feb. 1, 1943, giving an estimated additional tumor dose of 2,750 r. At this time the patient was re-examined and the genito-urinary surgeon determined again to attempt removal of the kidney, this time through a retroperitoneal approach, as an infected sinus tract remained following the first exploration. This time the nephrectomy was successful. The neoplasm in the upper pole of the kidney measured  $10 \times 6$  cm.; the remaining kidney parenchyma was compressed and atrophic, measuring  $3 \times 3$  cm. The microscopic picture was that of carcinoma of the Grawitz type, with radiation changes.

The only complication was a sinus tract (Fig. 8)



Fig. 8. Adenocarcinoma of Crawitz type (patient M. S.). The stomach and small intestine are flooded with dye injected through the fistulous opening in the nephrectomy scar. This closed without further surgery.

from the nephrectomy wound to the stomach. This was clearly demonstrated when dye injected into the sinus was seen draining into the stomach from the lower posterior angle of the nephrectomy scar. This closed gradually. The little patient has gained perceptibly, having increased in weight from 48 to 56 pounds in three months. Except for a cystic area in the left ilium, about as large as a penny, which has not changed in size in the past year, there is no evidence of recurrence or metastasis to date.

The preoperative radiation therapy definitely cut down the infection present, reduced the size of the tumor, and probably slowed up the extension of the growth for a period of nearly three years.

In the series under discussion postoperative radiation was given in most instances. It is in the treatment of recurrences and metastases that the results appear most discouraging (Fig. 9). The large solitary bone metastases do not show the response to radiation that is often demonstrated following irradiation of bone metastases secondary to a breast carcinoma. The following case report is illustrative:

H. F., a 41-year-old white male, reported to the Brooklyn Cancer Institute in June 1938 with a painful swelling over the sternum. He admitted to nocturia four to five times a night but had never noticed

any blood in his urine. On examination, he was found to have a subcutaneous oval swelling, 8 X 6 cm., apparently arising from the body of the sternum. A sense of resistance was felt in the right upper quadrant, suggesting a tumor. On roentgen examination, a greatly enlarged right kidney was demonstrated.

*Treatment of Primary Renal Tumor:* Between June 20 and July 12, 1938, the right kidney was cross-fired, with but minimal reduction in the size of the kidney mass. On Sept. 30, a right nephrectomy was performed. The pathological report was papillary adenocarcinoma of tubular origin.

*Treatment of Sternal Metastasis:* X-ray therapy was given from July 21 to Aug. 5, 1938: 2,000 r to 2 areas, an approximate tumor dose of 4,000 r.

Nov. 29, 1938: Twenty radium needles, 35 mm. in length, 2 mg., were inserted into the sternal mass for 100 hours, or an estimated 6,000 gamma roentgens.

Jan. 18, 1939: Twenty-four needles were reinserted into the sternal mass for an estimated 8,000 gamma roentgens. There was moderate shrinkage of the mass after the two interstitial radium treatments (Fig. 10).

March 29, 1939: Twelve needles were inserted into an extension over the manubrium, for an estimated tumor dose of 5,000 gamma roentgens. Except for moderate shrinkage in the mass after the second radium treatment, the growth of this metastasis was not influenced, in spite of relatively large doses of interstitial radium.

*Later Course:* Metastases appeared in the spine, with collapse, and in the femur, with pathological fracture. None of these metastases was influenced perceptibly by further radiation therapy. The patient died in July 1939, just over one year after admission.

#### SUMMARY

Prognosis is bad in all renal cortical tumors, since the growth is apt to remain symptomless for an initial period and metastases occur early.

The term "hypernephroma" is often used loosely to designate any renal neoplasm. Evidence has accumulated to cast doubt on the original Crawitz theory that hypernephromata originate from adrenal rests within the kidney.

The primary tumor may be radiosensitive, though the metastases are almost universally radioresistant. In a series of 54 patients with kidney tumor but 5 have survived over three and a half years without evidence of metastasis. All underwent



Fig. 9. Adenocarcinoma: Metastasis in right humerus before and after x-ray therapy. There was a two-month interval between the examinations. This is one of the exceptional cases where bone and calcific union took place following irradiation.

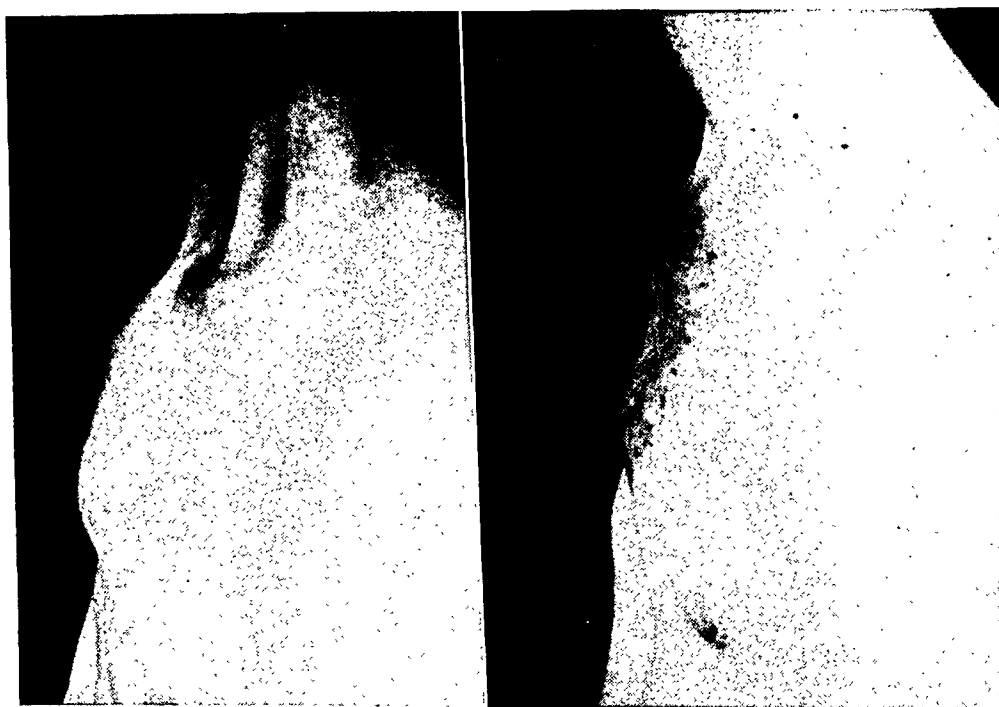


Fig. 10. Adenocarcinoma: Metastasis in sternum before and after irradiation. This metastatic mass received roentgen therapy—4,000 r tumor dose—and two applications of radium needles, giving estimated doses of 6,000 and 8,000 gamma roentgens, respectively, with only moderate reduction in size.



nephrectomy and received postoperative radiation therapy. One (M. S.) received large amounts of pre-nephrectomy roentgen therapy.

#### SUGGESTIONS

As leading symptoms are at first masked, the presence of kidney tumor should be considered among the differential diagnoses in all cases of unexplained back pain or loss in weight or strength. Transient hematuria should never be disregarded by the attending physician.

Diagnosis may be clinically established by roentgenography in conjunction with other clinical and laboratory findings. Large isolated secondary deposits in bone can be recognized and should not be confused with primary bone tumors, as giant-cell tumor, multiple myeloma, or sarcoma. Further studies as to the value of preoperative roentgen therapy appear to be warranted.

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#### REFERENCES

1. BOYD, WM.: A Text-Book of Pathology. Lea & Febiger, 4th ed., 1943. (a) p. 615. (b) p. 616.
2. GRAWITZ, PAUL: Die Entstehung von Nierentumoren aus Nebennierengewebe. Arch. f. klin. Chir. 30: 824, 1884.
3. CARSON, WM. J.: Tumors of the Kidney: Histologic Study. Tr. Sect. Urol., A. M. A., pp. 193-205, 1928.
4. JUDD, E. STARR, AND HAND, JOHN R.: Carcinoma of the Renal Cortex with Factors Bearing on Prognosis. Arch. Int. Med. 44: 746-771, 1929.
5. GREER, J. R., AND WELLS, H. G.: Absence of Adrenalin in Malignant Renal Hypernephroma. Arch. Int. Med. 4: 291-295, 1909.
6. BROOKS, CLYDE: Note on the Absence of Adrenalin in Malignant Hypernephroma. J. Exper. Med. 14: 550-556, 1911.
7. LÖHLEIN, M.: Über Fettinfiltration und fettige Degeneration der Niere des Menschen. Virchows Arch. f. path. Anat. 180: 1-50, 1905.
8. TUFFIER, M.: Le virilisme surrénal. Bull. Acad. de méd. Paris 71: 726-731, 1914.
9. EWING, JAMES: Neoplastic Diseases. Philadelphia, W. B. Saunders Co., 4th ed., 1940. (a) p. 823. (b) p. 817. (c) p. 810. (d) p. 819.
10. PORTMANN U. V.: Indications for Irradiation for Various Malignant Neoplasms of the Kidney. J. Urol. 31: 721-730, 1934.
11. KERWINI THOMAS J.: Papillary Carcinoma of the Renal Pelvis: Diagnosis and Treatment. Surg., Gynec. & Obst. 73: 759-765, 1941.
12. BRAASCH, WM. E.: Differential Diagnosis of Renal Tumors. South. M. J. 21: 425-434, 1928.
13. WATERS, CHARLES A.: Preoperative Irradiation of Cortical Renal Tumors. Am. J. Roentgenol. 33: 149-162, 1935.

# Malignant Tumors of the Kidney: Review of 117 Cases<sup>1</sup>

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FROM 1924 TO 1940, inclusive, 117 cases of malignant renal neoplasms were seen in the University of Minnesota Hospitals. The follow-up period extended to the end of 1942. In this group there were 94 cases of carcinoma of the renal cortex, 13 cases of Wilms' tumor, 9 cases of carcinoma of the renal pelvis, and one of sarcoma.

## HISTORICAL

The first reported case of carcinoma of the renal pelvis was that of Hedenius and Waldenstroem in 1878 in a 79-year-old man.

Grawitz in 1882 first described the tumor which bears his name. He recorded a typical case under the name of "struma aberrata suprarenalis" and showed its resemblance to adrenal structure. Harris in the same year described an adrenal-like tumor of the kidney, which he called "alveolar sarcoma of the renal capsule." Rokitansky, in his textbook, in 1861, gave what Newcomb states is a clear description of a Grawitz tumor. Later Birch-Hirschfeld introduced the term "hypernephroma."

At first, most investigators accepted the Grawitz theory of the suprarenal derivation of this tumor, but in 1908 Stoerck brought forth his findings favoring a renal rather than a suprarenal origin. From that time on the controversy has raged, and even to this day there is not unanimous agreement. At the present time the consensus seems to be definitely in favor of a renal origin.

The first accurate description of a mixed tumor of the kidney was apparently given by Eberth in 1872. Prior to that time all

malignant tumors of the kidney were thought to be carcinomas. Eberth believed these tumors came from inclusions of the wolffian body because of the presence in it of embryonal muscle cells, which he thought accounted for the presence of striated muscle fibers in the tumor. Other investigators, however, later showed these to be non-striated muscle fibers. Cohnheim in 1875 and Ribbert in 1886 attributed the origin of these tumors to aberrant germ plasm. In 1894 Birch-Hirschfeld reviewed the literature and agreed with Eberth that the origin is in the wolffian body. He suggested the term "adenomyosarcoma" for these mixed kidney tumors.

Wilms in 1894 wrote his classic monograph in which he presented the theory of origin that is generally accepted today. He believed the anlage of the tumor to be a fragment of primitive, undifferentiated mesodermal tissue of the type which gives rise to the myotome (source of striated muscle), the sclerotome (source of vertebral anlage), the nephrotome (wolffian body anlage), and the mesenchymal tissue from which smooth muscle takes its origin.

Busse in 1899 disagreed with Birch-Hirschfeld, stating that remnants of the wolffian body are not found in the kidney. He and Muus thought that the tumor arose from a segregated portion of renal blastema which failed to develop normally. Frazer in 1920 summarized the modern views of its origin. Hinman and Kutzmann suggested in 1924 that the simple tumors, the so-called sarcomata, can be explained by Birch-Hirschfeld's theory and the complex ones by Wilms' theory.

Geschickter and Widenhorn in 1934 proposed the term "embryonal nephroma." They state that the majority of these tumors are neither teratomatous nor mixed but represent a neoplastic exaggeration of

<sup>1</sup> From the Department of Radiology and Physical Therapy and the Department of Urology of the University of Minnesota and the University Hospitals, Minneapolis, Minn. Read by title at the Twenty-ninth Annual Meeting of the Radiological Society of North America, Chicago, Ill., Dec. 1-2, 1943.

normal growth processes in the growth zones of the renal cortex in late fetal life and the first few months of infancy.

The first successful removal of a Wilms' tumor was by Jessop of England in 1877 from a 2<sup>1</sup>/<sub>2</sub>-year-old boy, who died nine months later of a recurrence. Israel recorded the first surgical cure in 1894, in a 14-year-old boy on whom he had operated in 1888.

Heimann, in 1915, reported the first use of postoperative x-ray therapy on a Wilms' tumor. A nephrectomy was performed in July 1913 and irradiation was started in August. The patient received eight treatments but died three months later from metastases. Friedlaender in 1916 presented one of the first cases in which x-ray irradiation was used as a primary treatment. The tumor decreased in size but at autopsy, a few months later, metastases were found in the lungs and liver. The first preoperative x-ray therapy was apparently reported by Geraghty in 1923. It was intended to reduce the size of the tumor preparatory to operation, but the patient disappeared and did not return for nephrectomy. He was later found to have died, five and a half years after treatment.

For a more complete survey of the history of renal tumors, the reader is referred to the articles by Gilbert (29) and Kretschmer (30).

CLASSIFICATION

The classification of renal tumors which we have used is as follows:

- I. Renal Tumors in Children
  - A. Benign
    - Multiple tumors with tuberosc sclerosis
  - B. Malignant
    - Wilms' tumor
- II. Renal Tumors in Adults
  - 1. Parenchymal
    - A. Benign
      - (a) Fibroma
      - (b) Leiomyoma
      - (c) Lipoma
      - (d) Hemangioma
      - (e) Adenoma

- B. Malignant
  - (a) Liposarcoma
  - (b) Fibrosarcoma
  - (c) Adenocarcinoma (hypernephroma)
  - (d) Wilms' tumor
- 2. Pelvis
  - A. Benign
    - Papilloma
  - B. Malignant
    - Carcinoma

This classification was presented in a previous publication by Bell (1).

ADENOCARCINOMA OF THE KIDNEY CORTX  
(Hypernephroma)

Adenocarcinomas of the kidney cortex form by far the largest group in this series of malignant renal neoplasms, numbering 94, or 80 per cent, of the 117 cases. We regard adenocarcinoma of the renal cortex the same as hypernephroma. The disagreement which formerly existed regarding this neoplasm seems to be disappearing, and there is now a fairly general acceptance of its renal rather than suprarenal origin (2, 3, 8, 9, 14, 16).

TABLE I: AGE DISTRIBUTION OF 94 CASES OF CARCINOMA OF THE RENAL CORTX

Age	Proved Cases	Unproved Cases	Total
10-20	1	0	1( 1%)
20-30	3	0	3( 3%)
30-40	2	0	2( 2%)
40-50	22	6	28(30%)
50-60	22	4	26(27%)
60-70	30	3	33(35%)
70-80	1	1	2( 2%)

Of the 94 cases of carcinoma of the cortex, 81 were proved by histologic examination. The remaining 13, in which, for some reason, nephrectomy or biopsy was not done, were diagnosed on the basis of clinical symptoms, urography, and gross appearance of the tumor at operation.

Carcinoma of the renal cortex occurs almost entirely after the age of forty. In this series only 6 per cent of the patients were less than forty. Neff (23) reported 18 cases all beyond the age of forty. In MacKenzie and Parkins' (7) series 84 per cent were over forty and in Smith and Young's (22) 80 per cent. In a series pub-

TABLE II: SYMPTOMS IN 96 CASES OF CARCINOMA OF THE RENAL CORTEX COMPARED WITH OTHER REPORTED SERIES

	Author's Series		MacKenzie and Parkins	Smith and Young	Judd and Hand	Hyman	Belchor	Neff	Chute
	No.	%	%	%	%	%	%	%	%
Hematuria					69	80	..	36	88
Initial	21	22	38	48	..	..	35	..	..
Associated	43	46	24	16	..	..	18	..	..
Pain					83	30	..	28	60
Initial	16	17	43	34	..	..	..	..	..
Associated	42	45	30	36	..	..	..	..	..
Mass					78	80	..	12	62
Initial	11	12	8	9	..	..	5	..	..
Associated	22	24	54	29	..	..	42	..	..
Weight Loss									
Initial	7	8	..	..	..	..	..	..	..
Associated	12	13	..	..	..	..	..	..	..
Weakness									
Initial	5	5	5	6	..	..	..	..	..
Associated	8	9	18	17	..	..	..	..	..

lished by Judd and Hand (14) the average age at onset of symptoms was fifty-one years. The average age of the patients in our series at their first hospital visit was 53.4 years. The youngest was eighteen and the oldest seventy-six. Incidentally, the 18-year-old patient is alive and well, having been dismissed from follow-up eleven years after nephrectomy and x-ray therapy. Table I shows the age distribution of our cases.

Males were affected more frequently than females in this series, there being 59 men (63 per cent) and 35 women (37 per cent). In most of the other reported series, the relative frequency in men has been even higher. Belchor (6) and Priestley (16) reported 70 per cent males, Hyman (2) 74 per cent, Judd and Hand 68 per cent, and Neff 91 per cent.

The complaints varied considerably, but there were some which were found consistently enough to be of significance. Hematuria, pain, abdominal mass, weight loss, and weakness were most common. Hematuria, as either an initial or associated symptom, was present in 64 of the 94 cases. Pain was present in 58 cases, an abdominal mass in 33, weight loss in 19, and weakness in 13. Varicocele is frequently mentioned as a symptom, but in our series it was encountered only once.

Table II shows the frequency of the

various symptoms occurring initially and in association with others, along with the frequency in several other reported series. By initial symptom, we mean *single* initial symptom, unassociated with other symptoms until possibly later. If two or more symptoms appeared simultaneously, they have been listed as associated symptoms.

Hematuria was the initial symptom in 21 (22 per cent) of the cases and an associated symptom in 43 (46 per cent), making a total incidence of 68 per cent. Belchor reported hematuria in 53 per cent, Judd and Hand in 69 per cent, MacKenzie and Parkins in 62 per cent, Hyman in 80 per cent, and Smith and Young in 64 per cent.

Hematuria may be an early or a late symptom. It may be early clinically and late pathologically. It occurs when there has been an invasion of the renal pelvis or calices or, as Ljunggren (38) has pointed out, when there is venous stasis of the mucosa of the renal pelvis. Patients have presented themselves at the University Hospitals within two weeks after the first episode of hematuria only to find the tumor inoperable or metastases already present. Between bouts of hematuria there is not infrequently an interval, which may be as much as several months, during which the urine is normal, at least macroscopically. This quiescent period may be

dangerous since it may give the patient and even the physician a false feeling of security and the opportunity of making an early diagnosis may be lost. Obviously, every patient with hematuria deserves a complete examination, including urography. Several of our patients have had a history of intermittent hematuria for several years. It is difficult to establish whether the carcinoma was present during all those years or whether there was another basis for the bleeding. Certainly some malignant tumors of the renal cortex can be quite slow growing. Carlson and Ockerblad (34) report a case in which an x-ray and clinical diagnosis of carcinoma of the cortex was made. The patient refused surgery. Ten years later he was again seen and the tumor was found to be somewhat larger. This time a nephrectomy was done and a carcinoma of the cortex was found. Apparently the neoplasm had been present for all those years and yet was operable. This, of course, is an exception to the course these tumors ordinarily take.

Even though hematuria may frequently be a late symptom, it nevertheless seems that it is the one most likely to bring the patient to the physician in time to make possible an early diagnosis. When he comes because of weight loss, weakness, pain, or a mass, the disease is almost surely advanced.

Next to hematuria, pain was the most common complaint, occurring in 58 (62 per cent) of the 94 cases. Pain has been a frequent symptom in most of the reported series, having an incidence as high as 83 per cent in one series (Judd and Hand). It was most frequently located in the back and almost always in the lumbar region. Thirty-one patients complained of backache. Pain was present in the abdomen in 18 cases and in the flank in 6. There were only 3 cases of typical renal colic, and in one of these renal stones were present along with the tumor.

It is difficult to evaluate the significance of backache in these patients. Most of them are in the age group where some degree of backache is not unusual, and

in those cases in which it was present for several years the connection with the neoplasm might well be questioned. Two patients complaining of backache for seven and five years, respectively, were both alive and well at the close of the study, the first for a period of seven years and the second for five years. The patient complaining of backache for five years had hematuria for the same length of time, and in this case it seems reasonable that the backache was related to the tumor for this period. The other patient had no other complaints until one and a half years before coming to the University Hospitals, at which time she had her first attack of hematuria. The relation of the backache to the carcinoma for the five and a half years during which other symptoms were absent may well be questioned.

An abdominal mass was present in 33 (36 per cent) of the 94 cases. Many of the patients were not aware of the actual presence of a mass but experienced only a feeling of fullness and abdominal discomfort.

The classical triad of symptoms of carcinoma of the kidney cortex, namely, hematuria, pain, and abdominal mass, was present in only 10 cases, which is somewhat lower than in some other series. Belchor found 25 per cent presenting this triad, and Chute 31 per cent.

Nineteen patients complained of weight loss and in 7 of these it was the initial symptom. It is interesting to note that 5 of these 7 patients lived less than six months after first being seen at the University Hospitals. Weakness was the initial symptom in 5 cases and an associated symptom in 8.

Occasionally, there are cases in which none of the symptoms is associated with the urinary tract, and in that event much valuable time may be lost before attention is finally turned in the proper direction. Fifteen of our patients complained only of weakness, weight loss, epigastric distress, cough (from lung metastases), backache, or a combination of these symptoms, and the true nature of the lesion was not ap-

parent until after some study. In some cases, metastases in the lungs or bone may be the first indication of the presence of the renal lesion. Rolnick (26) found 14 out of a series of 54 cases in which none of the symptoms was referable to the urinary tract.

Metastases were demonstrated at the time of diagnosis in 14 of our 81 proved cases of carcinoma of the cortex. The site of metastasis was the bones in 7 cases, the lungs in 6, and the liver in 3. Late metastases are known to have developed in 28 of the 81 cases, the bones being the site of involvement in 13 cases, the lungs in 11, and the liver in 5. The frequency of bone metastases has been noted by Ewing (43) and others.

There is some question as to the advisability of nephrectomy in the presence of metastases at the time of diagnosis. In our series, nephrectomy was performed only 4 times when metastases were known to be present. One of these patients lived slightly more than one year, and each of the other 3 lived less than one year. Hyman is of the opinion that pulmonary or bone metastases not producing marked systemic effects, in the absence of cachexia, do not contraindicate nephrectomy. Ljunggren (44) is of this same opinion and cites a case in which a single pulmonary metastasis was followed after nephrectomy for three years, with only slight increase in size. On the other hand, Braasch and Griffin believe nephrectomy is contraindicated in the presence of pulmonary metastases and cite the fact that all 6 of their patients in this category lived less than one year (5). Waters (37) also feels that metastases are a contraindication to nephrectomy. It is our opinion that nephrectomy is not contraindicated by a single small metastatic lesion in one lung or in the bone, as such patients may have a considerable life expectancy.

Attempts have frequently been made to correlate the size of the tumor with the prognosis. It is well known that patients have survived for many years following the removal of a large kidney tumor with

no evidence of metastases at the time of surgery or subsequently. It is also well known that very small tumors—even as small as 1.5 cm. in diameter—may metastasize early. Obviously, no hard and fast rule can be laid down correlating the size of the tumor with the prognosis. In general, however, it seems that the prognosis is poorer with the larger tumors. That was true in our series, although the difference was less marked than in some of the other series. For the cases in which the tumor was less than 5 cm. in diameter or weighed less than 500 gm., the five-year survival rate was 50 per cent, whereas in the group in which the tumor was 10 cm. or more in diameter or weighed 1,000 gm. or more, the five-year survival was 38 per cent. In his series, Priestley (16) reported a 46 per cent five-year survival in the group in which the tumor weighed less than 500 gm., whereas for the group in which it weighed more than 1,000 gm. the figure was only 24 per cent. Bell has made the observation that metastasis is much less common in tumors less than 5 cm. in diameter than in those having a greater diameter. Out of a group of 149 autopsy cases which he reported, only 5 of the 65 cases in which the tumor measured less than 5 cm. in diameter showed metastases, whereas in the group in which the diameter exceeded 5 cm., 66 of 84 patients had metastases. It is interesting to note that in our series, in the group in which the tumor was small, 20 per cent expired in one year or less after first being seen at the Hospital, while the corresponding figure for the group in which the tumor was large was 42 per cent. Braasch and Griffin believe that fixation of the tumor is of greater prognostic import than its size.

Many writers have attempted to establish a correlation between the architectural pattern of the carcinoma and its degree of malignancy, classifying the lesions as alveolar, tubular, cordon, adenomatous, papillary, etc. However, as Bothe (36), Portmann (35), Hunt and Hager (8), Bell (1), and others have pointed out, two, and even several, of these patterns

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may exist in the same lesion. It would seem, therefore, that any classification or estimation of malignancy based upon the cellular arrangement of the lesion is likely to be unsatisfactory. This procedure may have some advantages, but we have not used it.

We believe that irradiation of metastases and recurrences is definitely worth while. Whether or not life is actually prolonged is a debatable question and one difficult to prove. There can be no doubt, however, as to the value of the procedure in palliation; the relief of pain and the return to a fairly normal life, even though temporary, make it a justifiable procedure. We have seen patients who have had almost constant pain and have been incapacitated by metastases, who, after a series of x-ray treatments to the metastatic lesions, were completely relieved of their suffering and were able to carry on a fairly normal life for many months, in some cases even for years. In this series, 25 patients received x-ray therapy to metastases or recurrences. Of this group, 9 lived one year or more following the course of irradiation, while 16 lived less than a year. Of the 9 patients who lived one year or more, one is still living seventeen months after irradiation of metastases in the lungs and one died two years and three months after irradiation of pulmonary lesions. Two patients expired three and a half years after therapy to bone metastases, and one four years after irradiation of cervical node metastases. Dean (18) is of the opinion that pulmonary metastases may be radiosensitive but he does not believe that bone metastases are. Koenig and Culver (4), however, feel that metastases to bone are frequently radiosensitive. In our few cases, the bone metastases have responded fully as well as the pulmonary metastases, and the relief of pain, which so frequently accompanies metastases in bone, is usually gratifying.

The value of x-ray therapy in carcinoma of the renal cortex, except for palliation, is a controversial subject. It seems to be agreed that irradiation alone is not enough

to control the disease and is only palliative (3, 18, 19, 21). Most writers feel that irradiation in conjunction with nephrectomy offers the best hope of cure. Munger (19) believes that preoperative irradiation is useful but warns that surgery should not be delayed following the completion of the treatments; the interval was never more than fourteen days in his series. Waters and Lewis (20), Kerr (45), and Dean also recommend preoperative irradiation. Dean suggests that preoperative x-ray therapy may partially prevent the dissemination of tumor cells at the time of operation, and in this opinion is supported by Munger. Preoperative irradiation may also, by reducing the size of the tumor, greatly facilitate nephrectomy. One of our patients was operated upon in March 1938, at which time a nephrectomy was contemplated. However, because of the size of the tumor and its adherence to surrounding structures, it was considered inoperable and nephrectomy was not done. The patient was then referred to the X-ray Department, where 1,450 tissue r were given to each of three fields in twenty-five days. In July, six weeks after completion of the course of x-ray treatments, a nephrectomy was successfully done. A course of postoperative irradiation, 1,450 tissue r to each of three fields, was given and, when last heard from in August 1943, the patient was alive with no evidence of disease.

The value of postoperative irradiation is not established. Hyman and Kerr do not believe it is of any value. Braasch and Griffin state that it has not been shown to be of much value in their experience. Portmann, however, recommends its routine use. He feels that cells which may have been left behind following nephrectomy may be rendered dormant and less likely to cause metastases. Dean does not agree with this and states that if the tumor is not entirely removed, x-ray therapy may delay but will not prevent a recurrence. Bothe (36) formerly favored irradiation and recommended that it be used in all malignant kidney tumors, but in a recent

article (21), he has reversed his former opinion and now feels that x-ray therapy does not improve the prognosis but is only palliative. It seems that to date no one has proved by statistical studies that post-operative irradiation leads to additional cures, but it does not seem improbable. Undoubtedly it delays the growth of possibly remaining cancer cells and for that reason we have considered it worth while in certain cases.

Rigler (46) is of the opinion that urography is of considerable value in the diagnosis of renal tumors. In those cases in which attention is first directed to a metastatic lesion, or in which the symptoms are vague and not particularly suggestive of disease in the urinary tract, excretory urography may be helpful in determining if a kidney is the site of the primary lesion. If the symptoms are referable to the urinary tract, excretory urography is helpful in determining the side involved. If this examination is negative or inconclusive, a retrograde pyelogram should be made.

#### TREATMENT OF CARCINOMA OF THE RENAL CORTEX

The treatment in this series of carcinomas of the renal cortex consisted of nephrectomy, nephrectomy plus irradiation, and irradiation alone. Whereas, in obtaining the figures which were presented in connection with the clinical picture, both the 81 proved cases and the 13 unproved cases were used, in compiling the survival figures and results of treatment only the proved cases were considered.

It is not within the scope of this paper to present or discuss the details of the surgical treatment. The results obtained in the cases in which surgery was used, either alone or in conjunction with irradiation, will be presented later.

The radiation therapy in this series was administered by a mechanically rectified unit, operating at 200 kv.p. and 30 ma. with 1 mm. of copper and 1 mm. of aluminum filter. The half-value layer was 1.4 mm. copper. At the present time we are

using 400 kv.p. and a half-value layer of 4 mm. of copper for the treatment of kidney tumors, but the machine permitting these factors was not available when the patients in this series were treated. Irradiation of the kidney area was usually through one anterior, one lateral, and one posterior field. The size of the fields varied with the size of the lesion and degree of extension into adjacent structures. A target-skin distance of 70 cm. was used for the anterior and posterior fields and 60 cm. for the lateral field. In the average case, one field was treated daily, the average daily dose being 250 r/air. The total amount given varied considerably. The largest amount given in one continuous series was 3,800 tissue r to the tumor in four weeks. This patient received 2,300 r/air to each of the three fields. Several patients received over 3,000 tissue r to the tumor, but the average tumor dose amounted to about 2,200 to 2,500 tissue r in the cases in which the series of treatments was completed. Six patients did not finish the series of treatments and failed to receive the amount of radiation which was planned for them.

Impiombato (13) states that the kidneys are among the least sensitive of all the organs and are practically unaffected by a dose of 2,000 r. Thus it would appear possible to give a considerably larger dose than this to the tumor without damaging the normal renal tissue. Dean (3) gives "a single portal 250 r daily until each (of 3 fields) has received 2,500 r." Waters (37) recommends "daily doses of 250 r" to each of three fields—anterior, lateral posterior—and in his cases the tumor dose varied from "1,100 r, the smallest, to 3,500 r, the largest." Munger gives multiple ports 300 r in air per day in rotation until "2,100 to 3,000 r per skin area" have been given.

It is advisable to observe patients closely during treatments. Blood counts should be made every few days and if there is any appreciable drop, therapy should be discontinued temporarily. A total white cell count of 3,000 has been adopted arbitrarily as the low level at which radiation



TABLE III: SEVENTEEN CASES OF PROVED CARCINOMA OF THE RENAL CORTX TREATED BY NEPHRECTOMY ONLY

Year	No. of Cases	Years Survival										Living
		1	2	3	4	5	6	7	8	9	10	
1930	1	0	0	0	0	0	0	0	0	0	0	0
1931	1	1	1	1	1	1	1	1	1	1	1	1 July 1941
1932	0	0	0	0	0	0	0	0	0	0	0	0
1933	0	0	0	0	0	0	0	0	0	0	0	0
1934	0	0	0	0	0	0	0	0	0			0
1935	4	3	3	3	3	3	3	3				2 April 1942 and July 1943. One died Nov. 1942
1936	1	1	0	0	0	0	0					0
1937	1	1	1	1	1	0						0
1938	3	3	3	3	2							3 Oct. 1941 and 2 in July 1943
1939	2 (1)	0	0	0								0
1940	4	3	2									2 July 1943
Cases	17	17	17	13	11	8	7	6	2	2	2	
Survival		12	10	8	7	4	4	4	1	1	1	

Figure in parentheses denotes presence of metastases at time of diagnosis.

will be given; below this level, therapy is stopped until the count increases again. It is well to watch the lymphocyte count as well as the total white count, as a drop in lymphocytes is also a danger signal and frequently occurs before the total white count starts to fall. Occasionally the total white count or the lymphocyte count decreases slowly and in this case it may be safe to continue treatment cautiously, but if the drop is rapid, treatment should be stopped completely until the count starts up again. In this event transfusions are of great value.

The temperature should also be checked. If an appreciable fever develops, it is usually advisable to decrease, or even stop, treatments until it subsides somewhat. High temperatures usually indicate a rapid destruction and absorption of tissue, as well as infection. In the presence of infection, large doses of x-rays may be actually harmful.

Radiation sickness is occasionally troublesome. Our patients are urged to drink large quantities of fluids and to lie down and rest soon after each treatment. Sedation may help to alleviate the sickness. Care of the bowels is also an important factor, and patients are instructed in the type of diet which will aid in elimination and are advised to take enemas when necessary. Vitamin B<sub>1</sub> is often given and seems to be of value in many cases.

RESULTS OF TREATMENT OF CARCINOMA OF THE KIDNEY CORTX

As was stated above, treatment included surgery alone (17 cases), surgery plus irradiation (48 cases), and irradiation alone (13 cases). Three cases received no treatment.

Seventeen cases of proved carcinoma of the renal cortex were treated by nephrectomy only. It should be mentioned here that this represents a rather selected group, as all of the patients were regarded as good surgical risks, without known metastases at the time of diagnosis (with one exception), and it was felt that the entire tumor was removed at surgery. If there was any doubt as to these conditions, the patient was referred for x-ray therapy. It is true, of course, that in many of those referred for irradiation, also, there were no known metastases and the entire tumor was believed to have been removed surgically.

Of the 8 patients treated by nephrectomy only up to the end of 1937, 4 lived five years or more. One, treated in 1935, lived seven years and died in 1942. The other 3 are living and well at the present time, one for ten years and the other 2 for seven years.

Of the 9 patients treated by nephrectomy only since 1937, 3 are living and well at the present time and one was living and well when last heard from in 1941. One of this group was treated in 1938 and has

TABLE IV: FORTY-EIGHT CASES OF PROVED CARCINOMA OF THE RENAL CORTEX TREATED BY X-RAY AND NEPHRECTOMY

Year	No. of Cases	Years Survival										Living	
		1	2	3	4	5	6	7	8	9	10		
1924	1 (*)	1	1	1	1	1	1	1	1	1	1	0	Died April 1941
1925	0	0	0	0	0	0	0	0	0	0	0	0	
1926	1 (*)	1	1	0	0	0	0	0	0	0	0	0	
1927	1 (*)	0	0	0	0	0	0	0	0	0	0	0	
1928	3	2	1	1	1	1	1	1	1	1	1	1	Dismissed from follow-up
1929	2	2	2	2	1	1	1	1	1	1	1	1	Dismissed from follow-up
1930	1 (1)	0	0	0	0	0	0	0	0	0	0	0	
1931	1	0	0	0	0	0	0	0	0	0	0	0	
1932	1	1	1	1	1	0	0	0	0	0	0	0	
1933	3	3	3	1	1	1	1	1	1	1	1	1	Aug. 1943
1934	5 (1)	4	3	3	3	3	1	1	1			1	July 1943
1935	2	2	1	0	0	0	0	0				0	
1936	7	6	5	4	3	3	3					3	Nov. 1942 and 2 in Aug. 1943
1937	8 (1) (*)	7	4	3	1	1						1	Nov. 1942
1938	5	4	3	3	3							2	Aug. 1943
1939	3	3	2	1								1	Jan. 1943
1940	4	2	1									1	July 1942, with metastases in the spine
Cases	48	48	48	44	41	36	28	21	19	14	11		
Living		38	27	19	15	11	8	5	5	4	3		
Per cent living		79	56	43	37	31	29	24	26	29	27		

Number in parentheses indicates metastases at the time of diagnosis.

Asterisk in parentheses indicates a case in which x-ray therapy was not given to the kidney but was given to metastases later.

actually survived five years, being alive and well in 1943. The other 2 patients were treated in 1940 and are both living and well in 1943.

The results of treatment in this group are shown in Table III.

Forty-eight cases of proved carcinoma of the renal cortex were treated by nephrectomy and irradiation. Thirty-six of these were treated up to and including 1937. In this group, 11 patients (30 per cent) survived five years or more, and 8 are living and well at the present time, 3 of them for ten years or longer.

Metastases were present at the time of diagnosis in 3 of these 36 patients, and all were dead in one year or less.

Four of the 36 patients treated up to the end of 1937 received no irradiation to the kidney area but did receive irradiation to metastases later. One of these lived for seventeen years from the time of surgery, one lived for two years, and the other 2 died in less than one year.

Twenty-four of the 36 cases treated by both nephrectomy and irradiation up to the end of 1937 received immediate post-operative prophylactic x-ray therapy. By

this we mean that: (1) the x-ray therapy was given as soon after the nephrectomy as possible, in most cases within one month; (2) no known metastases were present at the time treatment was initiated; (3) the full course of therapy as planned was administered. Of the 24 patients, 10 (42 per cent) survived five years or more after treatment. The results of treatment in this group are shown in Table VI.

Twelve patients with proved carcinoma of the renal cortex have been treated since 1937, of whom 7 are known to be dead. One, last heard from in 1941, had metastases in the lungs; one, last heard from in 1942, had metastases in the spine; and 3 are living and well in 1943. It is probable that the survival rate for this group treated since 1937 will not equal that for patients treated prior to that year, and it is possible that the survival rate of 42 per cent in the earlier group is higher than will be obtained over a longer period with a larger group of patients.

The results in the whole group of adenocarcinoma of the renal cortex treated by nephrectomy and irradiation are shown in Table IV.

TABLE V: THIRTEEN CASES OF PROVED CARCINOMA OF THE RENAL CORTX TREATED BY IRRADIATION ONLY

Year	No. of Cases	Years Survival					Living
		1	2	3	4	5	
1926	1 (1)	0	0	0	0	0	0
1928	1 (1)	1	1	1	1	0	0
1929	1 (1)	0	0	0	0	0	0
1932	1 (1)	0	0	0	0	0	0
1934	5 (5)	2	0	0	0	0	0
1937	2 (1)	1	1	1	1	1	1
1939	2	0	0	0			0
Cases	13	13	13	13	11	11	
Survival		4	2	2	2	1	

Number in parentheses denotes metastases at time of diagnosis.

TABLE VI: RESULTS OBTAINED IN 34 CASES OF CARCINOMA OF THE RENAL CORTX TREATED BY NEPHRECTOMY AND IMMEDIATE POSTOPERATIVE PROPHYLACTIC X-RAY THERAPY

Year	No. of Cases	Years Survival										Living	
		1	2	3	4	5	6	7	8	9	10		
1928	3	2	1	1	1	1	1	1	1	1	1	1	Dismissed from follow-up
1929	2	2	2	2	2	1	1	1	1	1	1	1	Dismissed from follow-up
1930	0	0	0	0	0	0	0	0	0	0	0	0	
1931	1	0	0	0	0	0	0	0	0	0	0	0	
1932	0	0	0	0	0	0	0	0	0	0	0	0	
1933	3	3	3	2	1	1	1	1	1	1		1	July 1943
1934	4	4	3	3	3	3	1	1	1			1	July 1943
1935	1	1	1	0	0	0	0	0				0	
1936	6	6	5	3	3	3	3					3	Nov. 1942 and 2 in Aug. 1943
1937	4	4	3	3	2	1						1	Nov. 1942
1938	4	3	3	3	3							2	Aug. 1943
1939	2	2	1	1								1	Jan. 1943
1940	4	3	2									1	July 1942 (now has metastases in spine)
Cases	34	34	34	30	28	24	20	14	13	9	6		
Survival		30	24	18	15	10	7	4	4	3	2		
Per cent survival		88	71	60	55	42	35	29	31	33	33		

Thirteen proved cases of carcinoma of the renal cortex were treated by irradiation alone. Ten patients in this group had metastases at the time of diagnosis and all are dead. One of these lived four years after therapy, 2 lived one year, and 7 died within less than a year. Three of these 13 patients did not have metastases at the time of diagnosis. Surgical exploration in one of these showed the tumor to be inoperable. Another was considered a poor surgical risk and surgery was not done. Both these patients were dead in less than one year. In the third case exploration showed an abscess in the kidney area, which was drained with removal of a large amount of necrotic material. The patient was given postoperative x-ray therapy in December 1937, about 2 months

after surgery, and was alive and well with no evidence of disease in August 1943. Table V shows the results obtained in this group treated by irradiation only. Of all the patients who came to the Clinic before the end of 1937, a total of 58, 17 have survived five years or more, an absolute five-year-survival rate of 29 per cent.

WILMS' TUMOR  
(Embryonal Adenomyosarcoma)

Thirteen cases of Wilms' tumor were seen at the University Hospitals from 1926 to 1940, inclusive. Five cases were proved by histologic examination and 8 were diagnosed by typical clinical findings, urography, appearance at laparotomy, and response to irradiation. All cases were

followed to the close of the study in 1942, and two of the three living patients were seen in June and July of 1943.

There were 9 males and 4 females in this series. In most of the reported series males predominate over females, although the opposite is sometimes true. The difference does not seem to be of any diagnostic significance.

Twelve of the 13 patients were six years of age or less. The youngest was three months and the oldest eleven years. This is essentially a disease of infants and young children, although cases have been reported in late adult life. Deming (41) is credited with having treated the youngest patient with this lesion, having done a nephrectomy in a 29-day-old infant. MacKenzie and Parkins reported a series of 11 cases, all in children under seven years, and in Kerr's series (15) all were under six years of age.

Abdominal mass, hematuria, and pain are the most common symptoms. An abdominal mass was present in 9 of our 13 cases (69 per cent), being the initial symptom in 5 cases and an associated symptom in 4. It was usually present only a few weeks until the patient was seen at the Hospital, but in 2 cases it had been present for more than a year. In one patient, a 6-year-old girl (Case 8), the mass had been present for a year and a half before she was first seen at the Clinic. She died fourteen months after laparotomy and x-ray therapy, with metastases in both lungs. The other patient was a girl of 18 months (Case 1), in whom the mass had been present for a year and a quarter when first seen. She died three months following nephrectomy and x-ray therapy, with metastases in both lungs. An abdominal mass is almost always present. Kretschmer (30) reported a series of 24 cases in which it was present in all. Kerr states that it is usually present.

Hematuria was present in 4 of the 13 cases (30 per cent), being the initial symptom in one and an associated symptom in 3. This is a somewhat higher incidence than is usually seen. This symptom

was present in only one of Kretschmer's 24 cases and in only one of Neff's series of 8. Kerr states that it occurs in from 10 to 25 per cent of the cases.

Pain was present in 4 cases and weight loss in 2. In Kretschmer's series, pain was present in 33 per cent and weight loss in 25 per cent.

In one case (Case 12) fever was the initial symptom and had been present for only two weeks when the patient was first seen at the Hospital. A palpable mass was found five days previously. Irradiation to the kidney area was given, but in spite of the early institution of therapy after the appearance of symptoms, the patient expired two months later with metastases in both lungs.

Known metastases were present at the time of diagnosis in 6 cases, and in each instance the site of metastasis was the lungs. Late metastases occurred in 3 cases, and here, too, the site in each instance was the lungs.

One case (Case 13) presents some especially interesting features.

A 2-year-old girl was admitted to the Hospital in April 1940 with an abdominal mass, abdominal pain, and hematuria of four months' duration. The patient was treated by x-rays only. From April 16 to 27 she was given 650 tissue r to the anterior and the same amount to the posterior right kidney area. From June 5 to 25 the anterior, lateral, and posterior right kidney areas were each given 1,250 tissue r. On Aug. 1 a roentgenogram of the chest revealed metastases in the apex of the left lung, and from Aug. 7 to 22 1,550 tissue r each were administered to anterior, lateral, and posterior left upper chest fields. Another course of therapy was given to the three kidney areas from Aug. 23 to Sept. 14, 1,300 tissue r being given to each field. A re-examination of the chest in February 1941 revealed metastases in the right lower lung field and accordingly 1,300 tissue r each were given to the anterior, lateral, and posterior right lower chest. Repeated roentgen examinations since that time show that the metastases in both of these areas have disappeared following therapy. This patient was alive and well with no evidence of recurrence in July 1943.

Kerr reported a case with pulmonary metastases which disappeared following x-ray therapy. Kretschmer also recorded a case with pulmonary metastases which

TABLE VII: SUMMARY OF 13 CASES OF WILMS' TUMOR

Case No.	Age	Sex	Treatment		Metastases		Living	Dead
			Surgery	Irradiation	At Diagnosis	Late		
<i>Proved Cases</i>								
1	1½ yr.	F	Nephrectomy Sept. 1934	Aug. 1934 Nov. 1934 to abdomen and lungs	Both lungs	...	...	Dec. 1934 (3 months)
2	3 yr.	M	Nephrectomy Jan. 1936	Dec. 1935 March 1936	None	Lungs	...	Sept. 1936 (8 months)
3	1½ yr.	M	Nephrectomy Dec. 1938	Oct. 1938 Jan. 1939	None	None	June 1943 4 years	....
4	3 mo.	M	Nephrectomy Sept. 1940	Sept. 1940 (postop.)	None	None	Oct. 1942 2 years	....
5	4 yr.	M	None	Oct. 1940 to abdomen and lungs	Both lungs	None	...	Jan. 1941 (3 months)
<i>Unproved Cases</i>								
6	6 yr.	M	Laparotomy Sept. 1926	Aug. 1926 Dec. 1926	Questionable to liver	None	...	Oct. 1930 (4 years)
7	11 yr.	F	None	Nov. 1929 March 1930	Both lungs	...	...	April 1930 (5 months)
8	6 yr.	F	Laparotomy Jan. 1931	Jan. 1931 April 1931 June 1931	.....	Both lungs	...	March 1932 (14 months)
9	6 yr.	M	None	To abdominal mass Oct. 1931 and Feb. 1932 To both lungs Nov. 1931	Both lungs	...	...	May 1932 (7 months)
10	3 yr.	M	None	March 1936	Both lungs	...	...	June 1936 (3 months)
11	9 mo.	M	None	April 1938 Aug. 1938	None	None	...	Feb. 1939 (10 months)
12	3 yr.	M	None	Oct. 1939	Both lungs	...	...	Dec. 1939 (2 months)
13	2 yr.	F	None	April 1940 and Aug. 1940 to abdominal mass Rt. lung Aug. 1940 Lt. lung Feb. 1941	.....	Both lungs	July 1943 ...	.....

disappeared following x-ray therapy, but in which, at autopsy, many deposits were found throughout both lung fields (31).

It seems that radiation therapy to metastases may be of considerable value, and Kerr, Dean, Bothe, and others recommend its use.

Table VII gives a brief outline of our 13 cases of Wilms' tumor. It will be seen that 9 of the patients died within fourteen months after therapy and one 4 years after laparotomy and x-ray therapy. Three patients are living and well, one for two years, one for three years, in July 1943, and one for four years and eight months in June 1943. These 3 cases were treated by different methods, the first by nephrectomy and postoperative x-ray therapy, the second by x-ray therapy only, and the

third by preoperative and postoperative x-ray therapy and nephrectomy.

It seems to be rather generally agreed that x-ray therapy is more useful in the treatment of Wilms' tumor than in any other malignant renal neoplasm. Dean states that in his few personal cases irradiation alone has given results as good as or better than irradiation plus surgery. He feels that surgery alone is practically of no benefit. Pohle and Ritchie (42) reported a case with a survival of three years and eight months after x-ray therapy only and McNeill and Chilko (28) had a patient living and well three years after x-ray therapy only. Mixer (37), Wade (40), and Ladd and White (47), on the other hand, believe that early nephrectomy offers the only hope of cure. Ladd and

White reviewed the literature and added a series of 60 cases of their own with results strongly favoring surgery in the treatment of this tumor. In their group of 60 cases they had 8 five-year survivals and 6 other patients were living two to four years after therapy; in this group of 14 cases, only 1 had received x-ray therapy. (The writers did not state how many of the entire group of 60 cases had received irradiation.) Nephrectomy was done in all 14 cases.

Some authors prefer preoperative x-ray therapy and nephrectomy (15, 32, 33). The reduction in tumor size which invariably follows irradiation greatly facilitates nephrectomy. Others (3, 16, 30) follow this with postoperative x-ray therapy. We are of the opinion that both preoperative and postoperative irradiation ought to be used, but statistical proof of their value is so far lacking. The results seem to be poor regardless of the type of therapy.

The radiation therapy in this group was administered with the same equipment that was used for the tumors of the cortex. Treatment was administered to an anterior and posterior field, and in some cases a lateral field was added. The usual daily dose was 200 r/air to one field. The amount varied somewhat but in general was about 1,500 tissue r per field and in several of the cases the course of therapy was repeated. In the average case this delivered between 2,500 and 3,000 tissue r to the tumor. Nephrectomy was performed in 4 of these cases, and 3 of them received preoperative and postoperative x-ray therapy. Two patients died in less than one year and one is living and well in June 1943, four years and eight months after therapy. One patient in whom nephrectomy was done received only postoperative irradiation and was living and well in October 1942, two years after therapy. Kerr gives 200 r/air per day to one of 3 ports until 3,000 to 4,000 r/air have been delivered to each port. Dean (3) states that if x-ray alone is to be used, "daily treatments of 75 r to 100 r should be

given to one of 3 ports until 3,000 r has been applied to each;" if therapy is to be preoperative, with the intention of decreasing the size of the tumor, "200 r can be given to a single portal (of 3 to be used) daily." After two cycles, if the radiation is well tolerated the daily dose can be reduced to 100 r. After nephrectomy has been performed, "100 r is given a portal daily until 2,000 r has been received by each of 3 portals." In the average child, this gives about 7 T.E.D. to the pedicle of the tumor.

The prognosis in this lesion is very poor. MacKenzie (39) places the mortality at 98 per cent, while Hyman, Kerr, and McNeill and Chilko all place it at above 90 per cent. Bothe reported a series of 7 patients, all dead within three and a half years. Mixer (37), however, believes the outlook after two years' cure is better with Wilms' tumor than with any other malignant renal neoplasms. The results of treatment in some of the reported series are as follows:

1. Kretschmer: 7 patients; 5 dead in 1 1/2 years or less; 2 living 2 1/2 and 3 1/2 years.
  2. Mixer: 26 of 27 patients dead in less than 18 months.
  3. Wollstein: 4 of 18 patients lived 10 years.
  4. Schippers: 4 of 145 patients living 4 years.
  5. Hyman: 94 per cent dead in less than 5 years.
  6. MacKenzie and Parkins: 13 patients; 11 dead; 2 living 7 and 2 years.
  7. Kerr: 14 patients; 12 dead in less than 4 years; 2 living 59 and 52 months.
  8. Geschickter and Widenhorn: 25 cases with no 5-year survivals.
  9. Bothe: 7 patients, all dead in 3 1/2 years or less.
  10. Dean and Pack: 16 patients; 13 dead and 3 lost from follow-up.
  11. Priestley and Broders: 65 patients, of whom 40 were followed; 36 dead; 1 living 13 years, 1 living 3 years, and 2 living 5 months.
  12. Ladd and White: 60 cases; 8 5-year survivals; 6 patients living 2 to 4 years.
- Authors' series: 10 of 13 patients dead in 4 years or less (9 in 14 months or less); 3 living, 1 for 4 years and 8 months, 1 for 3 years, and 1 for 2 years.

Eight of the authors' 13 cases have not been proved histologically, but the symptoms were so characteristic, as well as the

TABLE VIII: SUMMARY OF 9 CASES OF CARCINOMA OF THE KIDNEY PELVIS

Case No.	Age	Sex	Treatment		Results
			Surgery	Irradiation	
<i>Proved Cases</i>					
1	56	M	Nephro-ureterectomy with coagulation of intramural portion of bladder Jan. 1934	Preop. Aug. 1933	Living and well Aug. 1940, 7 years after start of therapy
2	55	M	Nephrectomy Oct. 1934 Ureterectomy Dec. 1934	Postop. Dec. 1934 Sept. 1935	Died Feb. 1936. Late metastasis to axilla, surgical scar, and chest. Survived 16 mo.
3	39	M	Nephro-ureterectomy Feb. 1935 Partial cystectomy July 1935	Postop. July 1935 Sept. 1935	Living and well when last heard from in 1937. Lost from follow-up
4	59	M	Nephrectomy Feb. 1935	None	Died May 1935. Survived 3 mo.
5	68	M	Nephrectomy Oct. 1935 Ureterectomy Dec. 1935	Postop. Oct. 1935	Died June 1936. Survived 8 mo.
6	71	M	Intracapsular nephrectomy April 1937	Postop. May 1937	Lost from follow-up
7	48	M	Nephrectomy Aug. 1939	Postop. Aug. 1939	Living and well Dec. 1942, 3 yr. 4 mo. after therapy
<i>Unproved Cases</i>					
8	40	F	Attempted nephrectomy Aug. 1934. Tumor not removed because of bleeding	Postop. Nov. 1934	Died Aug. 1935, one year after surgery
9	49	M	Laparotomy May 1937. Tumor not removed because of extension into surrounding structures	Postop. Aug. 1937 Jan. 1939 Sept. 1941	Died Feb. 1943. Survived 5 yr. 9 mo. after start of therapy

gross appearance in 2 cases at laparotomy and the response to irradiation, that the diagnosis can hardly be doubted.

#### CARCINOMA OF THE KIDNEY PELVIS

Nine cases of carcinoma of the kidney pelvis were treated at the University Hospitals from 1934 to 1940, inclusive. Seven cases are proved histologically, and 2 are unproved cases diagnosed by clinical symptoms, urography, and appearance on exploratory surgery. Eight patients of this group were males. Males usually predominate; in Priestley's series the ratio was three to one. The youngest patient was 39 and the oldest was 71. The average age was 54 years.

Hematuria was the most frequent symptom, occurring in 7 of the 9 cases. It was the initial symptom in 2 cases and an associated symptom in 5 cases. The longest duration of hematuria before admission was three years; incidentally, this patient was known to be alive and well seven years after preoperative x-ray therapy and nephrectomy. Hematuria is a very common symptom in carcinoma of

the renal pelvis. It was present in 100 per cent of Waters' series. Portmann does not give any figures, but states that it is an almost constant symptom.

Four patients complained of pain in the flank and 3 of pain in the back. Because tumors of the renal pelvis tend to cause obstruction and infection more than tumors of the parenchyma, pain is a relatively common symptom. Weakness and weight loss were present in 3 cases.

Seven of the 9 patients were followed until the close of the study. Of the other 2, one was followed for two years and then lost from follow-up and one was lost immediately after discharge. Two of the patients are living and well at the present time, one after seven years and one after three years. One patient died in February 1943, five years and nine months after laparotomy and x-ray therapy. Table VIII gives a brief summary of these cases.

The radiation therapy was administered to the tumors of the renal pelvis in the same manner and amount, and with the same precautions, as to the cortical tumors.

TABLE IX: RESULTS OF TREATMENT OF MALIGNANT TUMORS OF THE KIDNEY

Author	Five-Year Survival	Treatment
1. Hunt and Hager	18%	Nephrectomy and some x-ray therapy
2. MacKenzie and Parkins	16%	Nephrectomy and x-ray therapy
3. Beer	34%	Nephrectomy (no statement as to x-ray)
4. Walters	43% 17%	Nephrectomy and postoperative x-ray X-ray and radium only
5. Mintz and Gaul	11% (1900-23) 16% (1924-35)	Mostly surgery Mostly surgery
6. Priestley	38%	Nephrectomy and some x-ray therapy
7. Hyman	15%	Nephrectomy and x-ray therapy
8. Braasch	10%	
9. Neff	15%	Nephrectomy. No x-ray therapy
10. Judd and Hand	26%	Surgery and some x-ray therapy
11. Chute	15%	Nephrectomy. No x-ray therapy
12. Israel	34 cases—18 deaths from metastases in 2 years	
13. Garceau	43 cases—39 deaths from metastases in 3 years	
14. Cunningham	31 cases—22 deaths from metastases in 3 years	

In some of the cases, because of the tendency for tumors of the pelvis to implantation along the course of the ureter, the fields were extended to include the ureter of the involved side.

Carcinoma of the renal pelvis is a radio-resistant tumor. Bothe has pointed out that many of the cellular characteristics of this lesion are antagonistic to radiation therapy, which he feels is of palliative value only. Waters and Lewis (20), Waters (37), and Munger (19) all found this tumor to be radioresistant. For this reason many investigators recommend x-ray therapy only if there is extension outside of the renal capsule (8, 17, 35). Priestley states that in his series x-ray therapy has not been shown to be of any value.

There is a strong tendency in carcinoma of the renal pelvis for the occurrence of malignant implantations along the course of the ureter and in the bladder. For this reason, a complete nephro-ureterectomy, including a cuff of bladder at the ureteral orifice, is the operation of choice. This has been the procedure at the University Hospitals for the past several years and is advocated also by Dean, who believes that the tumor is not infrequently confined to the urinary tract. O'Connor (17) believes that the survival rate in this lesion will probably continue to improve

AUTHORS' SERIES  
(Treated up to and including 1937)

	No. of Cases	Five-Year Survivals	Per Cent Five-Year Survivals
Carcinoma of the renal cortex			
1. All cases admitted and proved (absolute survival rate)	58	17	29
2. Cases receiving immediate post-operative prophylactic x-ray therapy	24	10	42
Carcinoma of renal pelvis	6	1	16
Wilms' tumor	2	0	0
All malignant renal tumors	66	18	27

because of the increasing use of this type of operation. Frequent cystoscopic examinations of the bladder are indicated in order that malignant implantations may be found as quickly as possible. If the lesion is limited to the renal pelvis, metastases do not develop (35).

The results of treatment in this tumor are poor. Gilbert and MacMillan reported a series of 55 cases with no five-year survivals. MacKenzie and Parkins reported a 13 per cent five-year survival. In our 6 proved cases treated before the end of 1937, there was one survival for more than five years (16 per cent).



## CONCLUSIONS

1. In spite of improvements in methods of treatment, the mortality from malignant lesions of the kidney remains high.

2. Apparently the greatest obstacle to the reduction of this high mortality rate is the advanced stage of the lesion in most cases when first seen.

3. Hematuria is the symptom most likely to bring the patient to the physician in time to make possible an early diagnosis. Every patient, therefore, with unexplained hematuria should be given a thorough urological investigation.

4. Nephrectomy is the treatment of choice for malignant tumors of the kidney, with the possible exception of Wilms' tumor. In Wilms' tumor irradiation seems to be of greater value than in any other malignant renal neoplasm and should constitute an important part of the therapy. We feel that, if surgery is used, it should be in conjunction with preoperative and postoperative irradiation.

5. X-ray therapy is a valuable adjunct to surgery, (1) facilitating nephrectomy in many cases by reducing the size of the tumor; (2) perhaps rendering malignant cells dormant and reducing the danger of metastasis from manipulation at surgery; (3) inhibiting the growth of malignant cells which may be left behind.

6. In cases not suitable for surgery and without metastases, x-ray therapy may be valuable in prolonging life and affording palliation.

7. X-ray therapy is of value in the treatment of late metastases and recurrences. Life may or may not be prolonged, but relief of pain is frequently obtained.

## SUMMARY

1. An analysis has been made of 117 malignant renal neoplasms seen at the University of Minnesota Hospitals from 1924 to 1940, inclusive. This group is made up of 94 adenocarcinomas of the cortex (81 proved histologically), 13 Wilms'

tumors (5 proved), 9 carcinomas of the renal pelvis (7 proved), and one proved sarcoma.

2. A classification of renal tumors, both malignant and benign, previously published by Bell, has been included and used in this report.

3. The clinical picture of renal cancer, as brought out by these cases, has been presented, with a brief discussion of the more common symptoms.

4. Therapy consisted of surgery alone (17 cases), surgery plus irradiation (48 cases), and irradiation alone (13 cases). The technic of the roentgen therapy used in these cases is discussed.

5. The results of therapy in these cases have been presented, only those cases proved by histological study being used in compiling the survival rates.

In adenocarcinoma of the cortex, the five-year survival rate for cases treated by surgery alone is 50 per cent; by surgery plus irradiation 31 per cent; by surgery plus immediate postoperative irradiation 42 per cent; by irradiation alone 8 per cent (77 per cent had metastases at the time of diagnosis).

In the Wilms' tumor group there were no five-year survivals. Three patients, however, are still living and well with no evidence of disease, the longest for four years and eight months.

For carcinoma of the pelvis, the five-year survival rate is 16 per cent. The five-year survival rate for the entire series of kidney tumors (proved histologically) is 27 per cent.

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## BIBLIOGRAPHY

1. BELL, E. T.: Classification of Renal Tumors with Observations on Frequency of Various Types. *J. Urol.* 39: 238-243, March 1938.
2. HYMAN, A.: A Clinical Study of Malignant Tumors of the Kidney. *S. Clin. North America* 13: 347-364, April 1933.
3. DEAN, A. L.: Radiation Treatment of the More Common Kidney Tumors. *Am. J. Surg.* 38: 80-84, October 1937.
4. KOENIG, E. C., AND CULVER, G. J.: Value of Roentgen Therapy in Carcinomatous Metastases to Bone. *Radiology* 41: 38-41, July 1943.

5. BRAASCH, W. F., AND GRIFFIN, M.: The Prognosis in Renal Carcinoma and the Clinical and Pathologic Data Affecting It. *J. A. M. A.* 106: 1343-1346, April 18, 1936.
6. BELCHOR, G.: Malignant Tumors of the Kidney. *Semana med.* 1: 9-17, Jan. 7, 1943.
7. MACKENZIE, D. W., AND PARKINS, G. A.: Renal Tumors: Brief Review of a Series of Cases from Department of Urology, Royal Victoria Hospital. *Canad. M. A. J.* 20: 616-621, June 1929.
8. HUNT, V. C., AND HAGER, B. H.: Review of 271 Cases of Malignant Renal Neoplasms. *S. Clin. North America* 9: 149-159, February 1929.
9. WALTERS, W.: Malignant Tumors of the Kidney and Pelvis of the Kidney: Five-Year Cures Following Nephrectomy with Partial or Complete Ureterectomy. *Surg., Gynec. & Obst.* 56: 445-447, February 1933.
10. BEER, EDWIN: Some Aspects of Malignant Tumors of the Kidney. *Surg., Gynec. & Obst.* 65: 433-446, October 1937.
11. GASPAR, I. A.: Malignant Kidney Tumors: Study of Cases at Rochester General Hospital during 12-Year Period. *New York State J. Med.* 40: 1209-1217, Aug. 15, 1940.
12. MINTZ, E. R., AND GAUL, E. A.: Kidney Tumors: Some Causes of Poor End Results. *New York State J. Med.* 39: 1405-1411, July 15, 1939.
13. IMPIOMBATO, G.: Radiosensitiveness of Kidney Tumors. *Radiol. med.* (Milan) 22: 487-503, May 1935.
14. JUDD, E. STARR, AND HAND, J. R.: Carcinoma of the Renal Cortex, with Factors Bearing on Prognosis. *Arch. Int. Med.* 44: 746-771, November 1929.
15. KERR, H. DABNEY: Treatment of Malignant Tumors of the Kidney in Children. *J. A. M. A.* 112: 408-411, Feb. 4, 1939.
16. PRIESTLEY, J. T.: Survival Following Removal of Malignant Renal Neoplasms. *J. A. M. A.* 113: 902-906, Sept. 2, 1939.
17. O'CONOR, V. J.: Treatment of Malignant Tumors of the Adult Kidney. *South. M. J.* 34: 27-31, January 1941.
18. DEAN, A. L., JR.: Radiation Therapy of Tumors of the Renal Parenchyma in Adults. *J. Urol.* 39: 303-307, March 1938.
19. MUNGER, A. D.: Experiences in the Treatment of Certain Urinary Tract Malignancies with Supervoltage Roentgen Therapy. *Am. J. Surg.* 41: 220-227, August 1938.
20. WATERS, C. A., LEWIS, L. G., AND FRONTZ, W. A.: Radiation Therapy of Renal Cortical Neoplasms, with Special Reference to Preoperative Irradiation. *South. M. J.* 27: 290-299, April 1934.
21. BOTHE, A. E.: Pathology and Treatment of Renal Tumors. *U. S. Nav. M. Bull.* 40: 892-902, October 1942.
22. SMITH, E., AND YOUNG, A.: Kidney Tumors (Analysis of a Series of 118 Cases). *Canad. M. A. J.* 44: 149-152, February 1941.
23. NEFF, JOHN H.: Kidney Tumors: Report of Cases. *Virginia M. Monthly* 53: 701-704, February 1927.
24. CHUTE, A. L.: Hypernephroma. *Boston M. & S. J.* 194: 471-478, March 18, 1926.
25. STITES, J. R.: Neoplasms of the Kidney, Their Diagnosis and Treatment. *Kentucky M. J.* 30: 110-111, March 1932.
26. ROLNICK, H. C.: Tumor of the Kidney. *Illinois M. J.* 63: 375-377, April 1933.
27. GILBERT, J. B., AND MACMILLAN, S. F.: Cancer of the Kidney; Squamous-Cell Carcinoma of the Renal Pelvis with Special Reference to Etiology. *Ann. Surg.* 100: 429-444, September 1934.
28. MCNEILL, W. H., JR., AND CHILKO, A. J.: Status of Surgical and Irradiation Treatment of Wilms' Tumor. *J. Urol.* 39: 287-302, March 1938.
29. GILBERT, J. B.: Diagnosis and Treatment of Malignant Renal Tumors: Historical Data. *J. Urol.* 39: 223-237, March 1938.
30. KRETSCIMER, H. L.: Malignant Tumors of Kidney in Children. *J. Urol.* 39: 250-275, March 1938.
31. KRETSCIMER, H. L.: Adenomyosarcoma of Kidney (Wilms' Tumor): Report of 3 Cases. *Arch. Surg.* 41: 370-384, August 1940.
32. RANDALL, A.: Advantages of Pre-operative X-ray in Kidney Tumor in Children. *Ann. Surg.* 100: 462-475, September 1934.
33. SINKOE, S. J., FOWLER, M. F., AND BERGER, L.: Wilms' Tumor of Kidney. *Am. J. Surg.* 25: 163-169, July 1934.
34. CARLSON, H. E., AND OCKERBLAD, N. F.: Case of Unoperated Hypernephroma of Ten Years' Duration. *Am. J. Roentgenol.* 45: 221-222, February 1941.
35. PORTMANN, U. V.: Indications for Irradiation for the Various Malignant Neoplasms of the Kidney. *J. Urol.* 31: 721-730, May 1934.
36. BOTHE, A. E.: Effect of Roentgen Therapy upon Tumors of the Kidney. *Am. J. Roentgenol.* 33: 529-536, April 1935.
37. PACK, G. T., AND LIVINGSTON, E. M. (editors): Treatment of Cancer and Allied Diseases. New York, Paul B. Hoeber, Inc., 1940, Vol. 3 (Chapters by Waters and Bothe).
38. *Cyclopedia of Medicine*. Philadelphia, F. A. Davis Co. Vol. 7, 1937, p. 875.
39. CABOT, HUGH (editor): *Modern Urology*. Philadelphia, Lea & Febiger, 3d ed., 1936.
40. WADE, H.: *Renal Tumors*. Australia & New Zealand J. Surg. 5: 3-17, July 1935.
41. DEMING, C. L.: Congenital Sarcoma of Kidney in a Child of 29 Days. *J. A. M. A.* 80: 902-905, March 31, 1923.
42. POHLE, E. A., AND RITCHIE, G.: Malignant Tumors of the Kidney in Children, with Report of 6 Cases. *Radiology* 24: 193-205, February 1935.
43. EWING, JAMES. *Neoplastic Diseases*. Philadelphia, W. B. Saunders Co., 3d ed., 1928.
44. LJUNGGREN, E.: Symptoms and Prognosis of Hypernephroma. *Acta chir. Scandinav.* (suppl. 16) 66: 1-363, 1930.
45. KERR, H. DABNEY, AND STEPHENS, ROBERT L.: Roentgen Rays in Treatment of Malignant Tumors of Kidney in Adults. *Am. J. Roentgenol.* 50: 204-206, August 1943.
46. RIGLER, LEO G.: Personal communication.
47. LADD, WILLIAM E., AND WHITE, ROBERT R.: Embryoma of the Kidney (Wilms' Tumor). *J. A. M. A.* 117: 1858-1863, Nov. 29, 1941.

# The Diagnostic Value of Pneumoperitoneum<sup>1</sup>

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THE USEFULNESS of pneumoperitoneum in roentgenologic diagnosis has never been given the attention that it deserves, though many scientific papers regarding it have been published since Stewart and Stein (36) first popularized it in this country in 1919. Hinkel (19), Lewis (24), Sante (30), Thaxter (37), Stein (33-35), Rubin (29), and others have given us the early history of the procedure and advocated its use as a diagnostic measure. In spite of their excellent papers, however, there is still some hesitancy in its application.

Pneumoperitoneum is the presence of free gas in the peritoneal cavity. It may occur spontaneously or may be induced. Spontaneous pneumoperitoneum is usually the result of perforation of a hollow viscus at the point of a pathological change. The most frequent causes of perforation are penetrating peptic ulcer, carcinoma of the gastro-intestinal tract, infection of the bowel due to typhoid fever or tuberculosis, rupture of a distended loop of bowel following a partial or complete obstruction, and rupture of the bowel or diaphragm as the result of trauma. Balch (2) reports a case of pneumoperitoneum due to perforation of the transverse colon associated with a strangulated umbilical hernia.

Pneumoperitoneum can be brought about artificially in several ways. Rubin (29) has pointed out that it can easily be induced by intra-uterine insufflation when the tubes are patent. Banyai (3), Gaetan (16), and others have shown that pneumoperitoneum is occasionally produced dur-

ing pneumothorax treatment for tuberculosis. The passage of the needle through the pleural cavity and diaphragm allows the gas to enter and inflate the peritoneal cavity. Schiff, Stevens, and Goodman (32) state that pneumoperitoneum may occur after laparotomy and advise that this be borne in mind when patients complain postoperatively of pain in the shoulder, a feeling of fullness under the sternum, or pain in the chest. Though pulmonary infarct should not be overlooked as a possible cause of such symptoms, pneumoperitoneum can produce an identical syndrome. Induced pneumoperitoneum for diagnostic purposes is accomplished by the injection of gas through a needle or trocar inserted through the abdominal wall, as will be described later.

In addition to its diagnostic value, pneumoperitoneum is an excellent method of treatment in certain diseases. This phase is adequately covered by Banyai (4-10), Barnes (11), Burge (12), Fowler (15), Harper and Levin (17), Harrell (18), Warring and Thomas (39), and others, and will not be discussed in this paper.

The significance of spontaneous pneumoperitoneum in the diagnosis of perforation of peptic ulcer is widely recognized. The percentage of patients giving positive evidence of free gas in the peritoneal cavity varies in the many reported groups of cases, but the general average is accepted as from 75 to 80 per cent. It is generally agreed that the diagnosis of a ruptured peptic ulcer should be made as early as possible and that operation should be immediately undertaken. The amount of air present in the peritoneal cavity does not indicate the duration of the perforation, since in many instances a large amount of gas passes immediately into the peritoneal cavity, while in other cases practically none can be shown at any time.

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Johnson (22) believes that examination should be done as soon as possible after perforation, since he feels that the air present is soon reabsorbed. This, however, is an erroneous impression, since pneumoperitoneum produced by air will continue for days (31). It is important to remember that the amount of free gas in the peritoneal cavity is a definite indication as to the prognosis of the case, since the presence of large amounts of gas and much fluid greatly increases the mortality rate even with prompt operative procedures. There have, however, been reports of spontaneous pneumoperitoneum without evidence of peritonitis, and Hinkel (19) recorded one case in which there was no demonstrable visceral perforation or other disease. The authors have recently seen a patient with a spontaneous pneumoperitoneum discovered at fluoroscopy during the course of a routine gastrointestinal study. He gave a typical history of peptic ulcer of several months' duration. Five days before the fluoroscopic examination he had an attack of acute indigestion lasting for a period of several hours. Though he was hospitalized at that time, no x-ray examination was requested. He felt fine the day after the attack and had no further complaint of pain and showed no evidence of peritonitis. He was ambulatory at the time of the examination, although there were several hundred cubic centimeters of gas in the peritoneal cavity. A duodenal ulcer was demonstrated roentgenoscopically.

Rigler (27) has recently pointed out the necessity for frequent examinations of the patient with intestinal infection and obstruction and has emphasized that pneumoperitoneum can be diagnosed in roentgenograms made in the supine position. The importance of obtaining films of the best technical quality in any radiographic procedure cannot be overstressed, but this is particularly true of investigation of soft-tissue structures in the abdomen. The diagnosis of spontaneous pneumoperitoneum from scout films of the abdomen frequently taxes the ability of the radi-

ologist, and in any questionable case additional views in upright and lateral decubitus positions should be made.

We believe that the contraindications to induced pneumoperitoneum have been overemphasized. We feel that there is no danger from gas embolism when carbon dioxide is used and no great danger with oxygen. Definite cardiac insufficiency, in which the additional load imposed on the heart by the elevation of the diaphragm might prove disastrous, and an acute infection, which might be aggravated by the procedure, seem to us to be the only real contraindications. We have used pneumoperitoneum in chronic peritonitis, chronic bacterial endocarditis, subdiaphragmatic abscess, and pelvic inflammatory diseases without any evidence of activation of the disease process. We have no hesitancy in performing it in any patient whose symptoms call for more diagnostic information than is obtainable by other methods of examination, so long as there is no cardiac insufficiency or acute infection. The oldest patient in whom we have done a pneumoperitoneum study was 86 years of age and the youngest 2 months. In many instances we have found the use of an additional contrast material, such as barium or diodrast, at the time the pneumoperitoneum is done, to be of value. This was of great help in a case in which a large renal tumor was suspected. By the use of diodrast, normal kidney function could be demonstrated and it was evident that the mass was a retroperitoneal tumor not attached to the kidney.

Induced pneumoperitoneum is to be used in conjunction with and not in competition with other methods of diagnosis. Many times it will furnish confirmatory evidence of clinical findings; on the other hand, it may refute a previous clinical diagnosis. Induced pneumoperitoneum enables the radiologist to study the size, shape, and position of the abdominal and pelvic viscera; to determine the presence, location, extent, or absence of abdominal adhesions; to establish the location of masses present in the abdomen or retroper-

itoneal regions; to gain information regarding the presence and extent of peritoneal implants; to establish the location of a lesion as being above or below the diaphragm; and to identify an intrauterine or abdominal pregnancy.

The production of pneumoperitoneum is a simple and relatively harmless procedure. It has been done many hundreds of times throughout the country with few untoward effects since Alvarez (1) introduced the use of carbon dioxide in 1921. Carbon dioxide is readily available, has the advantage of being rapidly absorbed, and produces discomfort for only a few minutes. The use of oxygen or air prolongs the period of discomfort for many hours and offers no advantage over carbon dioxide as a diagnostic procedure, except in patients with massive ascites or those who are difficult to move, making rapid filming impossible. When paracentesis has been done, the use of air or oxygen produces no additional discomfort, while in patients difficult to move, the carbon dioxide is frequently absorbed before the filming is complete and two or three fillings are required to complete the examination. In such instances, it is better to use oxygen and, when the examination is complete, deflate the abdomen by reinsertion of the needle if discomfort occurs.

We claim no originality for the apparatus here described but point out its simplicity and easy availability. It can be readily obtained from any hospital supply room and the hospital carpenter can quickly fashion a mounting board. Two 1,000-c.c. infusion bottles are joined together at the bottom by a rubber tube at least 4 ft. long. One of the bottles (No. 1) is fitted with a two-way rubber stopper and glass tubes, one of the outlets being connected to the tube which goes to a 1,000-c.c. flask containing 200 c.c. of 5 per cent phenol, through which the carbon dioxide (or oxygen) is bubbled, and the other outlet to a rubber tube which will go to the patient. This bottle (No. 1) is now filled with sterile water. The tube to the patient is closed by a clamp. The carbon

dioxide is allowed to flow and displace the water from infusion bottle No. 1 to infusion bottle No. 2, thus being accurately measured by water displacement. When about 1,000 c.c. of water have been displaced, the gas is ready for injection. The needle or trocar is inserted into the peritoneal cavity through the abdominal wall about 1 inch below and 1 inch to the left of the umbilicus, which is the site agreed upon by most workers as the logical one for the purpose. Here there is little chance of puncturing a vital organ and the absence of adhesive processes is notable, even in the presence of extensive peritonitis. Lewis (24) uses the linea alba below the umbilicus in order to avoid any anomalous vessels in the abdominal wall. When ascites is present, we advise paracentesis immediately before injection of gas for pneumoperitoneum. The tube from the apparatus is connected to the needle or trocar after its insertion, and the clamp is opened. The injection of the gas is then accomplished by elevating infusion bottle No. 2, containing the water, thus using water pressure alone to inject the gas.

We inject from 1,500 to 2,000 c.c. of carbon dioxide in the average adult, though we have used as much as 5,000 c.c. If there is a massive ascites, the removal of the fluid will make it possible to introduce a much larger amount of gas into the abdominal cavity with little or no discomfort to the patient. In infants we use from 250 to 500 c.c.

After pneumoperitoneum is induced with carbon dioxide, it is important to make the radiographs as rapidly as possible. These are made at 30 inches distance, using cassettes with par speed screens. The technical factors are the same as for radiography of the chest. No grid or Bucky diaphragm is used. Our procedure is as follows: The radiographic tube is positioned so that the principal beam of x-ray will be parallel with the table top and centered at a point midway between the 12th rib and the crest of the ilium. With the tube in this position the cassette

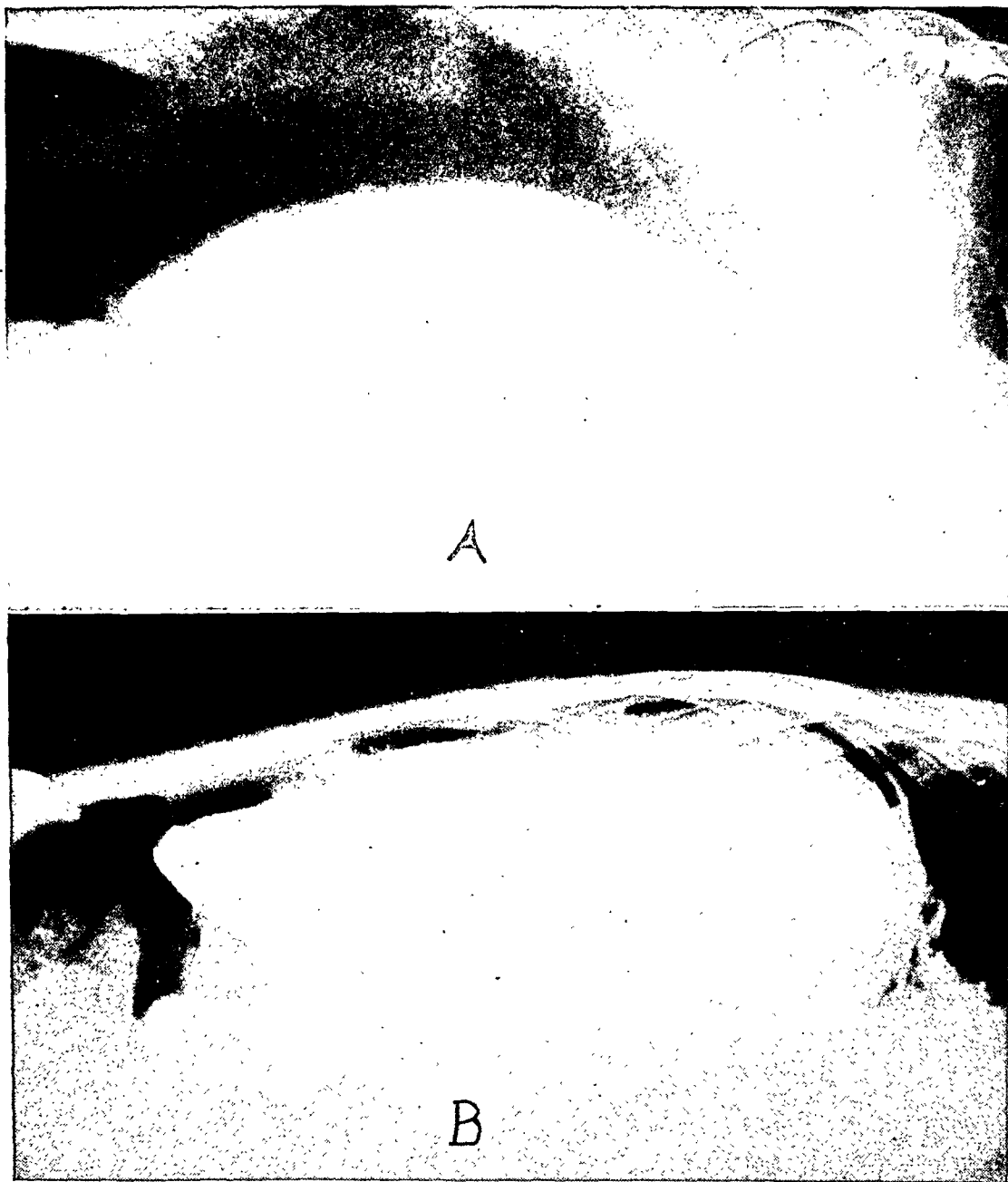


Fig. 1. A. There is a lesion in the pleural cavity above the diaphragm. The liver falls free from the wall of the abdominal cavity. There are no perihepatic or subphrenic adhesions. Note the digitations of the abdominal surface of the diaphragm.

B. There is a subphrenic abscess present with multiple subphrenic and perihepatic adhesions and with multiple fluid levels in the pockets of the abscess.

is placed at a right angle to the table. The first film is exposed with the patient supine on the table. The patient is then rotated into the right lateral decubitus position and a second film is exposed. The patient is then placed in the prone position with pillows under the chest and groins

so that the abdomen hangs free and does not bear the weight of the body. This allows a better investigation of the retroperitoneal space. A film having been exposed in this position, the patient is rotated into the left lateral decubitus position and another radiograph is made.

The radiographic tube is now positioned above the table and the patient is placed in the prone position. The table is then put into the Trendelenburg position. The x-ray beam is inclined in a cephalad direction through the pelvis, and a radiograph is made to outline the pelvic viscera. The patient remains prone on the table and the next film is exposed after the head of the table has been raised to an angle of  $60^\circ$  above the horizontal. This completes the radiography. When carbon dioxide is used, it is necessary, as stated above, that radiographs be made as rapidly as possible. If they are not technically satisfactory, additional gas will probably have to be injected, since the rate of absorption of carbon dioxide is too great to permit a repeat series.

By establishing a routine procedure for the examination, the radiologist will be better able to recognize early changes from the normal. We have found that stereoscopic projections do not greatly enhance the diagnostic value of the radiographs.

The usefulness of the procedure, as we have employed it, can best be illustrated by specific examples. Figure 1 shows two cases with an almost identical clinical course. It could not be determined from physical examination whether the pathological change in these patients was above or below the diaphragm. With the aid of pneumoperitoneum it is shown very definitely that the lesion in A is above the diaphragm, while that in B is below the diaphragm.

The size and contour of the liver and spleen are frequently diagnostic aids. Many times, however, it is impossible to establish these definitely from the physical examination, due to the thickness of the abdominal wall or its spasticity (voluntary or involuntary) or to the limitation of palpation because of the pain produced thereby. Frequently, also, erroneous impressions are gained from palpation. On two occasions in our series the diagnosis of an enlarged liver was shown to be wrong. One patient was a white male with a large

mesenteric cyst which measured approximately 5 cm. in diameter and was partially calcified. It was attached by adhesions to the lower border of the liver and to the mesentery. The cyst moved with respiration and on palpation felt like an accessory lobe of the liver or a nodular mass protruding from that organ. The second patient was a colored male who had a large mass in the region of the liver and several other palpable masses in the abdomen, but no jaundice and no symptoms indicating any liver damage. He had been operated on about eight years before, for intestinal obstruction, at which time a neurinoma was removed and a portion of bowel resected. He was then symptom-free for six years, after which his abdomen began to enlarge. The masses appeared to be rather firm and nodular. One, anterior to the surface of the liver, gave the impression that the organ was greatly enlarged. A transverse view, with the aid of pneumoperitoneum, showed definitely, however, that there was a normal liver beneath the mass (Fig. 2). The abdominal tumors are believed to be recurrences from the neurinoma, which is a type of tumor tending to recur locally and not to metastasize widely.

Martin (25) has shown there is a definite relationship between the size of the liver and spleen in various diseases and that important information can be obtained from pneumoperitoneum studies of these organs. The very large liver should always suggest the possibility of carcinoma. Enlargement of the liver occurs also in such diseases as leukemia, Hodgkin's disease, syphilis, amyloidosis, and long-standing suppurative infection. Cirrhosis of the liver may also produce enlargement if there has been an attempt at regeneration of liver tissue with a compensatory hypertrophy. A malignant tumor produces a nodular liver which is hard to distinguish from the hobnail liver of cirrhosis except for the size. Metastatic melanoma produces the greatest enlargement of the liver of any type of disease. The difficulty in differentiating between a neoplasm of the

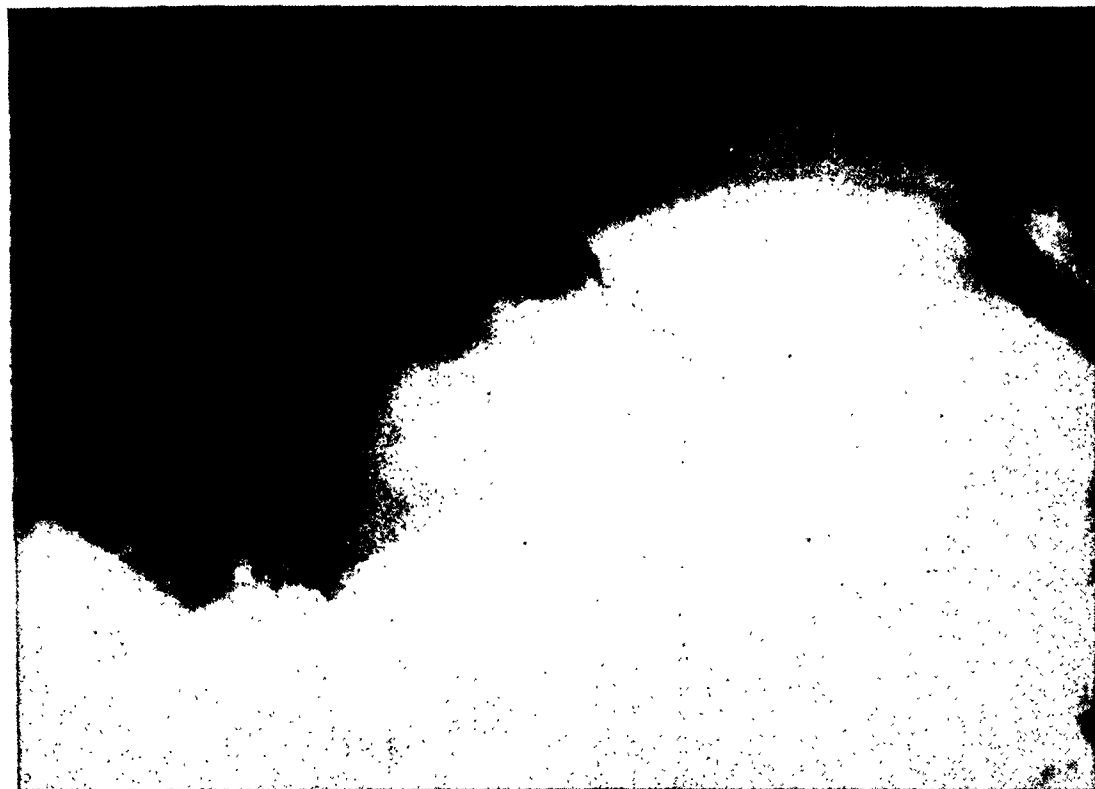


Fig. 2. Large tumor anterior to the liver and attached to it by adhesions. The liver can be identified beneath the mass.

liver and cirrhosis is due to the fact that frequently the latter produces some nodulation as a result of fibrosis with subsequent enlargement due to regeneration of liver tissue, producing an appearance quite like that of cancer. In such instances the size of the spleen is of diagnostic importance.

Very small livers are frequently discovered only with the aid of pneumoperitoneum, although their presence may be strongly suspected from clinical findings. The small, smooth liver of an acute yellow atrophy is readily distinguishable from the small, nodular liver of chronic cirrhosis. The size of the spleen is also an important factor in the differentiation between acute yellow atrophy and atrophic cirrhosis, since it is usually normal in size in acute yellow atrophy and considerably enlarged in atrophic cirrhosis.

The position and size of the spleen are of importance in determining the operability of certain of the familial hemolytic anemias. The presence or absence of adhesions can

be established. Martin (25) has given a comprehensive description of the spleen in many of the diseases causing splenomegaly. He points out that the most common cause of a greatly enlarged spleen is leukemia, though subacute bacterial endocarditis, cirrhosis of the liver, and Hodgkin's disease must all be considered in the presence of splenomegaly. A large, smooth spleen is found in chronic malaria, which is rather prevalent in the southern states. The similarity in the appearance of the spleen in leukemia, familial hemolytic jaundice, acute bacterial endocarditis, etc., makes their diagnosis impossible from study of that organ alone.

The diagnosis of tumors in the mid-portion of the abdomen is difficult but can be accomplished in many instances. Early diagnosis of tumors in the head of the pancreas will give the patient a better chance for palliation and possible cure. In one of our patients a diagnosis of tumor of the head of the pancreas without evidence of liver metastases was made.



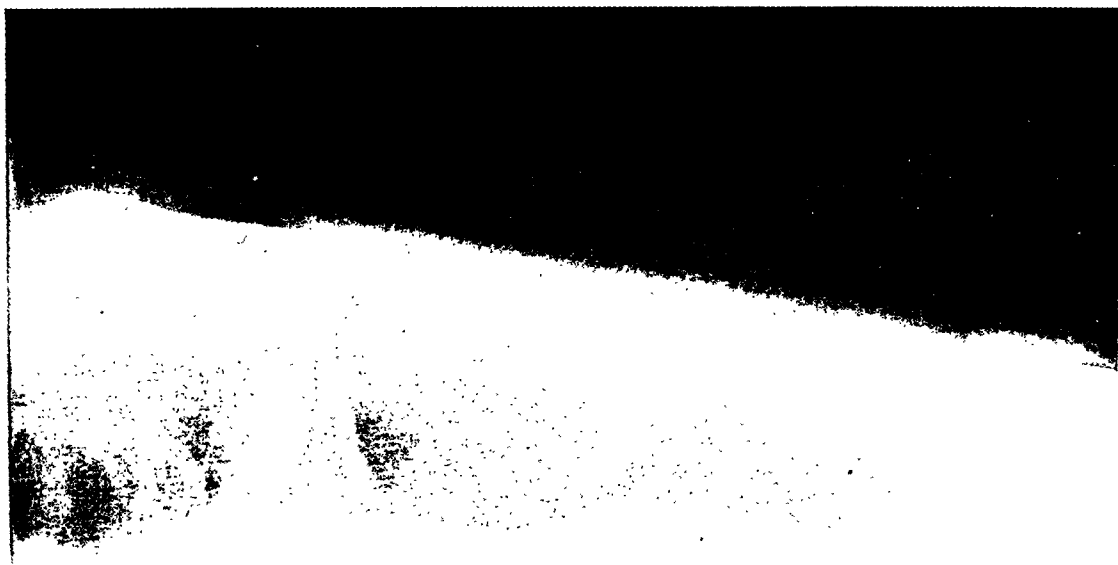


Fig. 3. Postoperative tent-like adhesions are readily demonstrable on this radiograph.

At operation the pancreatic tumor was not resectable. Complete obstruction of the common bile duct necessitated a choledochoduodenostomy. Weak radium needles were placed in the tumor with threads leading out of the abdomen through a cigarette drain. High-voltage x-ray therapy was also applied while the needles were in place. The patient is now at work and symptom-free, except for a ventral hernia, fourteen months after operation. There has been no recurrence of the ascites. The previously palpable mass can no longer be felt. Such palliation is certainly worth while.

The recognition of certain types of infection and adhesions in the peritoneal cavity is also of great value. Tuberculous peritonitis is clearly shown in most instances but is usually diagnosed before resort to pneumoperitoneum. The usefulness of the procedure in this disease is limited to the determination of its extent and the amount of involvement in the peritoneal cavity and as a therapeutic procedure. In one case in our series the diagnosis of peritonitis was made only following pneumoperitoneum, since the chief

complaint had been in the chest. The presence of a low-grade peritonitis was not suspected. This condition had caused the omentum to adhere to a large area of the anterior abdominal wall. There were also many thick abdominal adhesions.

Pneumoperitoneum is the only accurate method of determining the presence, location, and extent of peritoneal adhesions. The gas brings the adhesions into clear relief. Postoperative tent-like adhesions are shown in Figure 3.

In one of the cases in our series the clinician felt a mass in the abdomen which he believed to be a retroperitoneal tumor. Pneumoperitoneum examination, however, showed it to be in the anterior abdomen, closely associated with the abdominal viscera. A diagnosis of mesenteric tumor was made and confirmed at operation. The pathological report showed it to be a sarcoma.

The recognition of pelvic viscera is usually possible, although occasionally there are multiple adhesions in the pelvis and very little gas can be forced into it. The patient should be catheterized or should empty the bladder immediately before

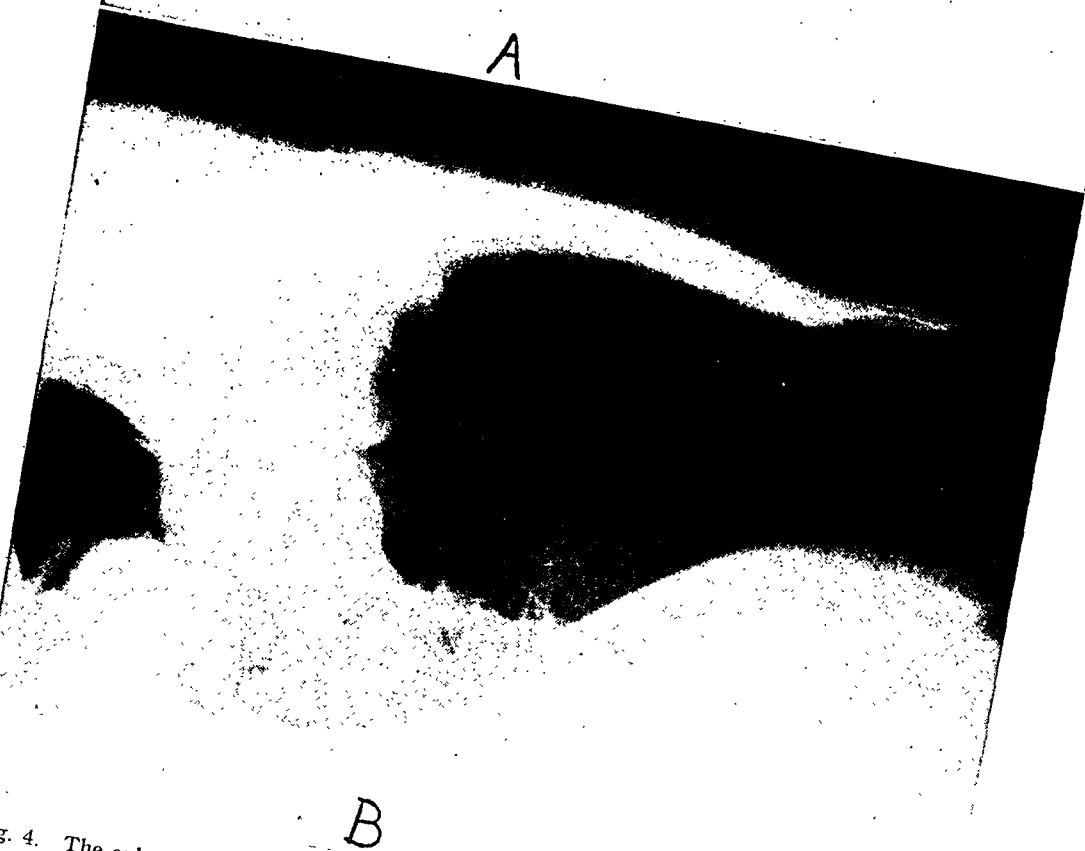


Fig. 4. The enlarged ovaries in these two cases are quite similar in appearance. The films show that they were not adherent to other structures at the time of examination.

the induction of pneumoperitoneum. Figure 4 shows the similarity between tumors of the ovary. In each of these cases there was a large, rounded, freely movable mass in the region of the ovary, with no evidence of peritoneal metastases. Operation in one of these cases has resulted in a three-year survival without evidence of recurrence, although the ovary removed was carcinomatous. The second patient was not operated upon and no follow-up examination has been possible.

The use of pneumoperitoneum in determining traumatic rupture of the urinary bladder has been advocated by Vaughan and Rudnick (38). They believe that the injection of gas into the bladder by catheter is the safest method. If the rupture is into the abdominal cavity, a pneumoperitoneum is produced, which can be readily recognized. If the rupture is extraperitoneal, the extravasation of gas in tissue is quite evident.

Stein (33-35), Mathieu (26), and others have pointed out the value of pneumoperitoneum in pregnancy. An intrauterine pregnancy is easily identified; it is also quite simple to identify an ectopic pregnancy. The pneumoperitoneum should be induced by abdominal puncture and should not be attempted by transuterine insufflation. There should be no hesitancy in utilizing pneumoperitoneum as an additional aid in the diagnosis of suspected tubal or abdominal pregnancy.

Pneumoperitoneum is also used, as pointed out by Faulkner (14), in the investigation of the diaphragm. It may be employed in conjunction with pneumothorax or in cases where pneumothorax is not possible due to pleural adhesions.

Sante (31) has shown that there is a very definite place in the field of radiation therapy for the use of pneumoperitoneum. This permits the removal of the intestines from the field of irradiation. It also allows an accurate investigation of the size, shape, and position of the uterus and adnexa and can be utilized in the determination of the x-ray portals so that the maximum intensity of the beam is directed

to the location of the tumor to be treated. The technic of this procedure is well presented in his paper and does not need to be repeated here.

#### SUMMARY

Pneumoperitoneum is a valuable diagnostic procedure to be used in conjunction with other methods of examination. The necessary apparatus is available in any radiographic department, and the procedure entails little additional expense and effort. Properly carried out, it is without serious danger to the patient and frequently yields vital information.

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#### REFERENCES

1. ALVAREZ, W. C.: Use of CO<sub>2</sub> in Pneumoperitoneum. *Am. J. Roentgenol.* 8: 71, February 1921.
2. BALCH, FRANKLIN G., JR.: Pneumoperitoneum Due to Perforation of the Transverse Colon in an Umbilical Hernia. *New England J. Med.* 222: 1034-1035, June 20, 1940.
3. BANYAI, ANDREW L., AND JURGENS, GEORGE H.: Accidental Pneumothorax During Pneumoperitoneum Treatment. *Am. Rev. Tuberc.* 42: 688-690, November 1940.
4. BANYAI, ANDREW L.: Respiratory Motion of the Lung During Artificial Pneumoperitoneum Treatment: Roentgenological Study. *Am. J. Roentgenol.* 41: 37-41, January 1939.
5. BANYAI, ANDREW L.: Mechanical Effect of Artificial Pneumoperitoneum and Phrenic Nerve Block: Comparative Study. *Arch. Surg.* 38: 148-154, January 1939.
6. BANYAI, ANDREW L.: Visceroptosis During Artificial Pneumoperitoneum Treatment. *Radiology* 33: 751-758, December 1939.
7. BANYAI, ANDREW L.: Radiologic Measurements of the Apico-Basal Relaxation of the Lung During Artificial Pneumoperitoneum Treatment. *Am. J. M. Sc.* 196: 207-211, August 1938.
8. BANYAI, ANDREW L.: Intraperitoneal Pressure During Treatment with Artificial Pneumoperitoneum. *Arch. Int. Med.* 63: 547-552, March 1939.
9. BANYAI, ANDREW L.: Principles of the Pneumoperitoneum Treatment of Pulmonary Tuberculosis. *Dis. of Chest* 7: 402-406, December 1941.
10. BANYAI, ANDREW L.: Observations on the Radiological Chest Volume During Artificial Pneumoperitoneum. *Radiology* 31: 48-51, July 1938.
11. BARNES, JOSEPHINE: Artificial Pneumoperitoneum in Pulmonary Tuberculosis and Pregnancy. *Lancet* 2: 976-977, Nov. 4, 1939.
12. BURGE, FRANK WALTON: Pneumoperitoneum, Oxyperitoneum, and Nitroperitoneum in the Treatment of Pulmonary and Abdominal Tuberculosis. *Dis. of Chest* 4, 14-18, October 1938.

13. CASE, J. T.: Review of Three Years' Work and Articles on Pneumoperitoneum. *Am. J. Roentgenol.* 8: 714, December 1921.
14. FAULKNER, WILLIAM B., JR.: Diaphragmatic Hernia and Eventration; Use of Pneumothorax in Differential Diagnosis. *Am. J. Roentgenol.* 45: 72-73, January 1941.
15. FOWLER, W. O.: Pneumoperitoneum in the Treatment of Pulmonary Tuberculosis. *Am. Rev. Tuberc.* 44: 474-478, October 1941.
16. GAETAN, L. R.: Accidental Pneumoperitoneum: Report of Eight Cases. *Am. Rev. Tuberc.* 39: 537-539, April 1939.
17. HARPER, FRED R., AND LEVIN, OSCAR S.: Gastrointestinal Disturbances Following Phrenic Paralysis Relieved by Pneumoperitoneum. *Am. Rev. Tuberc.* 42: 130-133, July, 1940.
18. HARRELL, C. LYDON: Pneumoperitoneum in the Treatment of Pulmonary and Abdominal Tuberculosis. *Dis. of Chest* 6: 273-277, September 1940.
19. HINKEL, CHARLES L.: Spontaneous Pneumoperitoneum without Demonstrable Visceral Perforation. *Am. J. Roentgenol.* 43: 377-382, March 1940.
20. IMBACH, R.: Pneumoperitoneum After Laparotomy. *Schweiz. med. Wchnschr.* 71: 1574-1575, Dec. 20, 1941.
21. IMMERMAN, SAMUEL L.: Encapsulated, Non-suppurative Subphrenic Gas Peritonitis. *Ann. Surg.* 106: 303-307, August 1937.
22. JOHNSON, SYDNEY E.: Frequency of Air under the Diaphragm in Perforated Gastric and Duodenal Ulcer: Report of 42 Consecutive Cases. *J. A. M. A.* 103: 295-296, Jan. 23, 1937.
23. JONES, H. A.: Pneumoperitoneoscopy; Cauterization of Adhesions between Liver and Diaphragm. *Am. Rev. Tuberc.* 42: 805-806, December 1940.
24. LEWIS, B. OLIVER: Artificial Pneumoperitoneum. *Texas State J. Med.* 35: 300-304, August 1939.
25. MARTIN, CHARLES L.: Roentgenologic Studies of the Liver and Spleen. *Am. J. Roentgenol.* 37: 633-643, May 1937.
26. MATHIEU, ALBERT: Diagnosis of Tubal Pregnancy. *J. A. M. A.* 108: 366-369, Jan. 30, 1937.
27. RIGLER, LEO G.: Spontaneous Pneumoperitoneum: A Roentgenologic Sign Found in the Supine Position. *Radiology* 37: 604-607, November 1941.
28. RILANCE, A. B., AND WARRING, F. C., JR.: Pneumoperitoneum Supplementing Phrenic Paralysis. *Am. Rev. Tuberc.* 44: 323-334, September 1941.
29. RUBIN, I. C.: Subphrenic Pneumoperitoneum Produced by Intra-Uterine Insufflation of Oxygen as Test of Patency of Fallopian Tubes in Sterility and in Allied Gynecological Conditions. *Am. J. Roentgenol.* 8: 120, March 1921.
30. SANTE, L. R.: Present Status of Pneumoperitoneum as an Aid in the Radiological Diagnosis of Abdominal Lesions. *Southwestern Med.* 11: 529-533, December 1927.
31. SANTE, L. R.: Pneumoperitoneum as an Aid in Pelvic Irradiation for Carcinoma of the Cervix. *Am. J. Roentgenol.* 46: 689-699, November 1941.
32. SCHIFF, LEON, STEVENS, RICHARD J., AND GOODMAN, SANDER: Pneumoperitoneum Following Use of the Flexible Gastroscope. *Ann. Int. Med.* 14: 1283-1287, January 1941.
33. STEIN, IRVING F.: Why Pneumoperitoneum? *Radiology* 28: 391-398, April 1937.
34. STEIN, IRVING F.: Gynecographic Aid in the Diagnosis of Ectopic Pregnancy. *Am. J. Obst. & Gynec.* 43: 400-409, March 1942.
35. STEIN, IRVING F.: Case of Unruptured Tubal Pregnancy Diagnosed by Gynecography. *Am. J. Obst. & Gynec.* 43: 525-526, March 1942.
36. STEWART, W. H., AND STEIN, A.: Roentgen Ray Study of the Abdominal Organs Following Oxygen Inflation of the Peritoneal Cavity. *Am. J. Roentgenol.* 6: 533-542, 1919.
37. THAXTER, LANGDON T.: Spontaneous Pneumoperitoneum in Perforated Peptic Ulcer: Roentgen-Ray Analysis of 44 Cases. *Am. J. Roentgenol.* 44: 853-857, December 1940.
38. VAUGHAN, R. T., AND RUDNICK, D. F.: New and Early Sign of Ruptured Bladder. *J. A. M. A.* 83: 9-12, July 5, 1924.
39. WARRING, FREDERICK C., JR., AND THOMAS, R. M.: Spontaneous Air Embolism; Observed in a Case of Pneumoperitoneum. *Am. Rev. Tuberc.* 42: 682-687, November 1940.



# Responsibility of the Roentgenologist in the Wartime Duodenal Ulcer Problem<sup>1</sup>

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MY INTEREST IN the wartime problem of duodenal ulcer lies in the fact that the Selective Service regulations place the responsibility for the diagnosis of peptic ulcer upon the roentgenologist. There are many phases in the life cycle of an ulcer of the duodenum which present perplexing problems roentgenologically. There are also differences of opinion among roentgenologists and gastroenterologists concerning the roentgen criteria in the varying early developmental phases of the disease. It seems opportune, therefore, to clarify certain conceptions regarding the roentgen signs of the different stages of duodenal ulceration.

Although the roentgen diagnosis of duodenal ulcer is best established on anatomic findings, these changes are not always demonstrable. One must remember that the roentgen portrayal of a duodenal ulcer deformity depends upon the stage of development of the ulcer at the time of the examination and that it is not constant in all cases. Because of the protean character of the roentgen phenomena the roentgenologists and gastroenterologists are often unaware of the varying picture in the early stages.

Many authorities claim a high percentage of correct diagnoses in duodenal ulceration. This has led to the general belief that the roentgenologic diagnosis is made with comparative ease and should be possible in nearly all cases. Actually, the only cases diagnosed with ease are those which reveal marginal deformities or readily demonstrable ulcer niche defects. In the early stages of ulceration there are ordinarily no anatomic contour deformities, and the diagnosis is therefore more

difficult. Both the gastro-enterologist and roentgenologist have long been aware of the fact that there are a large number of cases, presenting all of the clinical manifestations of duodenal ulceration, that are not confirmed by roentgen examination based solely upon the criterion of bulbar deformity. This group, however, presents mucosal roentgen changes which undoubtedly have been overlooked. The varying roentgen picture of the different phases of duodenal ulcer has led to some confusion regarding the diagnosis of this condition.

According to military regulations, those having active peptic ulcers are not acceptable for service. There has, however, been little effort on the part of the induction boards to prevent selectees with ulcers entering the armed services. The majority of cases could be eliminated by systematic fluoroscopic examination of the stomach. By far the greater number of peptic ulcers in men in the armed services have their onset prior to induction. Cases in which the ulcer syndrome developed after induction cannot be attributed to service disability, but rather to an aggravation by military life of a pre-existing condition, formerly symptomless.

The incidence of duodenal ulceration among military combat personnel has been exceedingly high and constitutes a major medical problem. The British and Canadian experiences with combat soldiers have revealed an incidence of peptic ulcer in medical patients of over 50 per cent. On the basis of rejections by the selective service system, Kantor found that disqualifications for peptic ulcers were 5.5 per cent. In the Surgeon General's statistics for 1940, the digestive system ranked third as a cause of admission to sick report

<sup>1</sup> Read by title at the Twenty-ninth Annual Meeting of the Radiological Society of North America, Chicago, Ill., Dec. 1-2, 1943.

and fifth as a cause of discharge for disability, while in 1941 it was shown to be responsible for 17.9 per cent of all hospital admissions.

In military practice the diagnosis of duodenal ulceration is generally made on definite objective evidence of a crater or marginal deformity. While this finding is the basis of all roentgen diagnoses of duodenal ulceration, there are other definite signs, the recognition of which is equally important. Roentgen demonstration of a marginal deformity or ulcer crater or niche defect is pathognomonic of duodenal ulceration. The ulcer niche, however, can be demonstrated only by the compression procedure, and its incidence varies considerably. In our experience it is seen in about one-third of all cases. Often the niche defect exists without marginal deformity and may not be demonstrable. In certain stages of the ulcer the contour of the duodenal bulb may not be affected. When one considers that the most frequent factor in the production of a bulbar deformity is the spastic phenomenon due to a contraction of muscle fibers surrounding the ulcer, it can readily be seen that in those cases which have not yet reached this stage no marginal deformity will be observed.

With the advance of roentgenologic knowledge regarding the early mucosal changes, it is now possible to detect most cases of duodenal ulcer with a high degree of accuracy. There has been too little consideration given to the roentgen findings in the various morphologic phases encountered in the development of duodenal ulceration. Although the pathologic stages have been amply recorded, there has been little interest in the protean phases of the roentgen picture in the early stages. It is true that these early roentgen signs are often evanescent and thus are easily overlooked, but failure to appreciate this changing picture may account for differences noted on repeated examinations.

There are four stages in the development of a duodenal ulcer: (1) edema and

induration, (2) superficial erosion, (3) penetrating ulcer, (4) healing and cicatrization.

Roentgen recognition of early duodenal ulceration must be based upon the mucosal changes before the marginal deformities occur. The majority of ulcers are small and shallow. If a bulbar deformity is present, it is usually out of proportion to the true size of the ulcer. Scant attention has been given to the morphologic findings in ulceration involving the mucosa. The normal duodenal mucosal pattern shows a longitudinal arrangement of the rugae parallel with the long axis of the bulb. In duodenal ulceration there is a distinct change in this pattern, which may be seen in all stages of the development of the ulcer. The following changes may be observed: (1) veiling of the mucosal pattern; (2) edema and superficial induration in the ulcerated area, elevating the mucosa; (3) obliteration of the folds over the ulcer area; (4) thickening of the folds; (5) distortion of the longitudinal folds; (6) cross-bar folding of mucosa at right angles to the long axis of the duodenal bulb; (7) a criss-crossing, lace effect, or checker-board appearance of the mucosal pattern; (8) convergence of the folds toward the ulcer.

One of the earliest roentgen signs of duodenal ulcer is fragmentation of the barium-filled bulb. The production of the fragmentation sign is based upon two factors: localized edema and spasm. This sign is usually constant during the examination, but it may be transient. Although it is not so pathognomonic as marginal deformity or the niche, it is sufficient for a diagnosis, and since it occurs in the first stage of an ulcer, when marginal deformities are generally absent, it is most important that it be recognized. It is best demonstrated on fluoroscopic examination, utilizing manual compression. It is not ordinarily seen in roentgenograms made by the usual procedure, but may be demonstrated by the spot compression technic. It is often seen in an otherwise normal appearing duodenal bulb. On the

other hand, it is not always demonstrable.

In the early stages of duodenal ulcer one must also consider duodenal changes occurring in addition to the mucosal findings. These changes are physiological and produce important secondary roentgen phenomena. Often they give the first clue to the presence of an ulceration. The following secondary duodenal signs may be observed: (1) irritability of the duodenal bulb; (2) altered motility; (3) altered tone; (4) spasticity.

#### COMMENT

There is a fairly large proportion of symptomless young male adults who harbor a duodenal ulceration; while another group has intermittent slight dyspepsia, which is considered by the laity to be of no consequence. There is no way of knowing whether such persons have duodenal ulcers unless a thorough roentgen gastro-intestinal study is made. It is among these groups that some cases of duodenal ulceration are later found in the armed services. A third group, with known digestive disturbances, will also show duodenal ulcers after induction.

Many selectees claiming to have an ulcer have been declared negative on the basis of a gastro-intestinal roentgen study showing no anatomic deformity and accordingly have been accepted for service. After a period of three to five months many of these have been hospitalized for duodenal ulcer.

Still others, who have been under treatment for duodenal ulcer for a number of years, have been inducted into the armed services, only to be discharged for this

disability. Some of these have had complications possibly brought on by their military activities.

Since the burden of proof of the presence of peptic ulcer rests with the inductee, a large number of men will invariably be accepted for military service with this disease. The military authorities have placed the responsibility for the diagnosis of peptic ulcer on the roentgenologist. Those draftees who present evidence of having this condition may be re-examined by the induction board or at military hospitals. Unfortunately, at the time of the re-examination some of them present no signs of an ulcer, on the basis of army x-ray regulations, and are inducted into the services. Many of these are later found to have a duodenal ulcer, sometimes with complications, such as perforation or hemorrhage.

It must be emphasized that, since the regulations require that an anatomic deformity must be demonstrable for a diagnosis of duodenal ulcer, many cases go undiagnosed. It is commonly known that duodenal ulceration in its early stages does not produce anatomic contour deformities of the duodenal bulb, but little consideration has been given to this phase of the problem. For this reason, and because of the failure to consider the earlier mucosal changes, a fairly large number of draftees are inducted into the services with duodenal ulcers. The strain of military service in such cases will often aggravate an already present peptic ulcer and provoke severe digestive symptoms.

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# Primary Malignant Neoplasm of the Shoulder Joint, with Report of a Case<sup>1</sup>

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PRIMARY MALIGNANT tumors of the joints are relatively rare, and the literature on the subject is limited. The chapter on "Tumors of Tendon Sheaths, Joints and Bursae" in Geschickter and Copeland's *Tumors of Bone* offers perhaps the best discussion (1). Codman (2) in his book, *The Shoulder*, covering an experience of many years, mentions no type of neoplasm arising in that joint.

Fibrosarcoma arising in the joint capsule appears to be the most common type of malignant tumor of the joints. Because of its slow growth in its early stages and a tendency to remain local over a period of months or years, this tumor is difficult of recognition and is probably often confused with benign fibroma, though the latter more commonly involves the tendon sheath. Since cartilage cells occur normally in the villous processes of the synovial membrane, loose bodies derived from synovial tags or fringes may become converted into cartilage, with the development, in some instances, of true chondromata. These may be single, but are usually multiple. Synovial sarcomas, though rare, may arise from the specialized connective-tissue cells, or fibrocytes, lining the synovial sheath (3). In the shoulder joint are various layers of connective tissue from the cells of which a malignant sarcoma may arise. The many reflections of the joint capsule and the extensive range of movement, with the possibility of repeated trauma, may be among the factors intimately concerned with the development of tumors.

## ANATOMY

Of all the joints, the shoulder probably possesses the widest range of motion. It

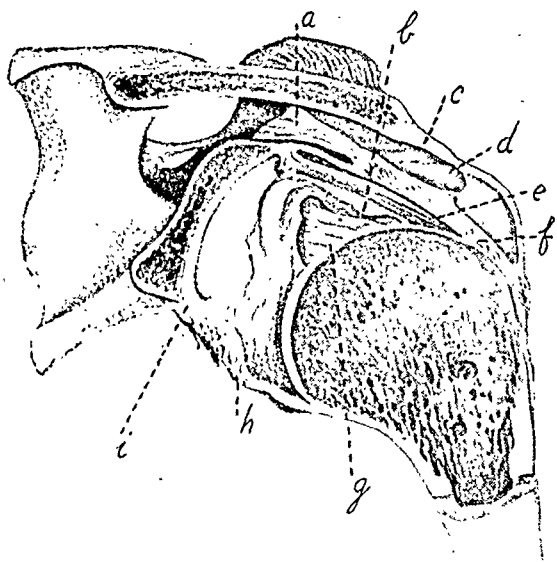


Fig. 1. Vertical section through shoulder joint, with head of humerus pulled away from glenoid, exposing fossa, capsular sac, biceps, tendon, etc. The sheath of the biceps tendon is continuous with the synovial lining of the capsule. *a.* Supraspinatus muscle. *b.* Glenohumeral ligament. *c.* Fibrous tissue between acromion and humerus. *d.* Subacromial bursa. *e.* Tendon of biceps. *f.* Capsular ligament. *g.* Tendon of subscapularis after it has penetrated fibrous capsule of joint. *h.* Capsular ligament. *i.* Glenoid ligament, i.e., marginal fibrocartilage. From Morris' *Anatomy: Joints of Man*, 1879, Plate XX.

may be considered as a shallow oval cup, deepened by circumferential fibrocartilage, in which the spherical head of the humerus rests, the entire articulation being enclosed in a loose sac—the capsule—intimately adherent to the margin of the glenoid cavity and possessing many reflections. The head is held in position not so much by ligaments as by muscles and the effect of atmospheric pressure. Reflections of the capsule are extensive and varied. It is intimately adherent, around the dorsal aspect of the scapula, to the prominent rough surface of the glenoid process, and even extends to the great scapular notch. Above, it is firmly attached to the root of the coracoid. On the inner side, it is attached to the ventral

<sup>1</sup> From Woodlawn Clinic and Hospital, Chicago, Ill. Read by title at the Twenty-ninth Annual Meeting of the Radiological Society of North America, Chicago, Ill., Dec. 1-2, 1943.



the ventral and dorsal surfaces of the scapula tend to strengthen the capsule, especially at their insertions, and are mainly responsible for holding the head of the humerus against the glenoid cavity. Sometimes a well formed sesamoid is present where the subscapularis is inserted into the lesser tuberosity.

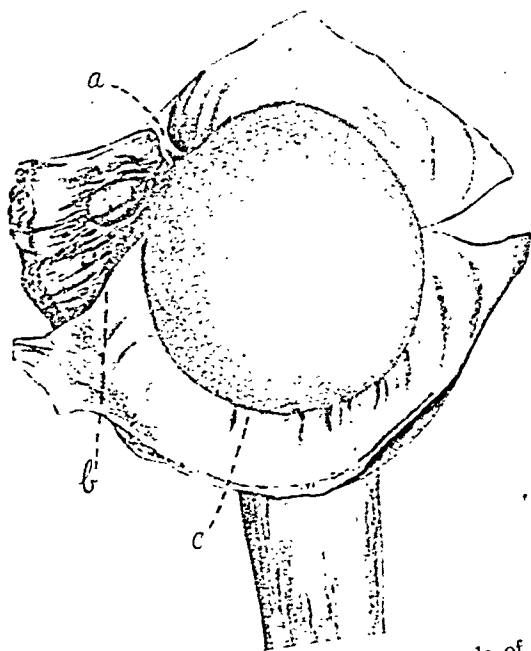


Fig. 2. Head of humerus with capsule of shoulder cut and reflected backward. The capsule forms a loose sac enveloping the head of the humerus. a. Glenohumeral ligament at its attachment. b. Sesamoid bone in subscapularis tendon. c. Reflection of some of the deeper fibers at lower and outer side. From Morris' *Anatomy: Joints of Man*, 1879, Plate XIX.

surface of the glenoid process and at a variable distance beyond, its fibers often extending several or more centimeters beyond the neck of the scapula and passing upward to the under surface of the coracoid. By these reflections and attachments, a rather loose pouch is formed. Below the glenoid fossa, the capsule blends with the origin of the long head of the triceps, arising from the axillary border of the scapula, and in its passage downward and outward its sheath is attached to the underside of the capsule. At the head, the upper one-half of the capsule is fixed to the anatomical neck and sends prolongations downward over the bicipital groove and biceps tendon. The lower half of the capsule descends upon the humerus further from the margin of the articular facet, but some fibers are reflected upward to be attached close to the articular margin and thus form, to a slighter degree, a fibrous investment for this part of the neck of the humerus (Fig. 1).

The tendons of the shoulder muscles which pass outward over the capsule from

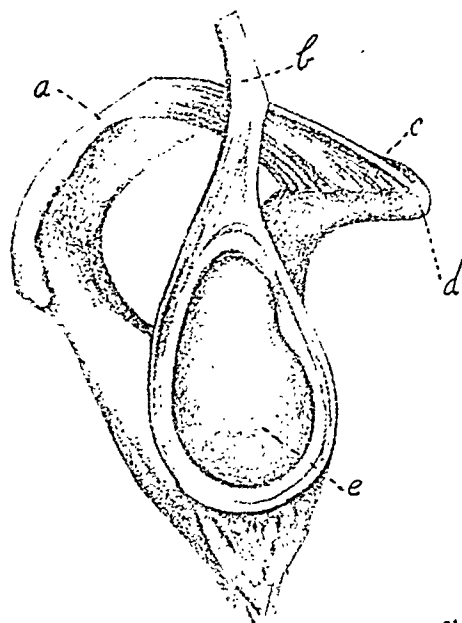


Fig. 3. Glenoid ligament thickened by fibers of the biceps tendon which bifurcates and passes around the rim, blending with joint cartilage. a. Acromion. b. Tendon of biceps cut and held up. c. Coraco-acromial ligament. d. Coracoid process. e. Glenoid fossa of scapula. From Morris' *Anatomy: Joints of Man*, 1879, Plate XIX.

The capsule presents a uniform thickness as a whole, but the inner portion below the border of the subscapularis is sometimes thicker. In the hip joint, greater thickness of certain portions of the capsule is essential for firmness and support; in the shoulder joint, this same degree of strength and steadiness is not required, since the upper limb is not weight-bearing but is almost solely designed for rapidity and extensive range of movement. Another band, sometimes called the coraco-humeral ligament by the older anatomists, which strengthens the capsule, extends from the greater tuberosity to the coracoid process, passes along the capsule in the line of the biceps tendon, with

which it becomes incorporated, and bridges over the bicipital groove. Reflections of the capsule in the form of bands covered by synovial membrane, called the glenohumeral process of the capsule, help to form a groove or sulcus for the biceps tendon and hold it in check to prevent any tendency to inward displacement (Fig. 2).

Besides the support which the capsule receives from the tendons, added strength is supplied by a strong fascia which passes over and beneath these reflected bands.

The glenoid ligament is a narrow band of fibrocartilage which is attached to the margin of the glenoid fossa and helps to deepen the cavity. At the upper part of the fossa the biceps tendon is prolonged into the glenoid ligament and forms an integral and important part of it. In fact, the tendon sends into the ligament fibers which wind around nearly the entire circumference of the socket (Fig. 3).

The articular cartilage covering the glenoid socket is thicker at the circumference than in the center and assists the glenoid ligament to deepen the cavity. The synovial membrane lines the fibrocartilaginous rim—the glenoid ligament—and is then reflected over the inner surface of the capsule to its attachment at the humerus. Sometimes the synovial cavity communicates with the subscapular bursa; less frequently with a bursa beneath the tendon of the infraspinatus muscle on the lateral aspect of the joint. Prolongations of the synovial membrane are frequently present, the most important of which are a pouch-like extension beneath the coracoid process and fringes along the margin of the glenoid cavity. These are the structures from which pathologists believe synovial sarcoma arises.

The blood supply of the shoulder is rich. It is derived chiefly from the subclavian artery through the suprascapular, and from the axillary artery through the anterior and posterior circumflex, the subscapular, dorsalis scapulae, and sometimes also through a branch direct to the joint. Free anastomosis occurs in the

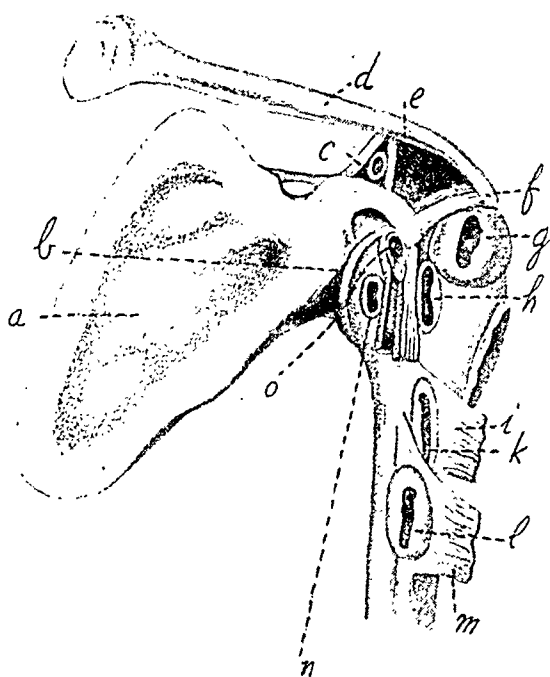


Fig. 4. Bursae in connection with shoulder joint. *a*. Ventral surface of scapula. *b*. Cut tendon of subscapularis muscle. *c*. Bursa between coracoclavicular ligaments. *d*. Clavicle. *e*. Coracoid process. *f*. Tip of acromion. *g*. Subacromial bursa. *h*. Occasional bursa between biceps and coracobrachialis and capsule of joint. *i*. Teres major. *k*. Bursa beneath teres major. *l*. Bursa beneath latissimus dorsi. *m*. Latissimus dorsi. *n*. Bursa between subscapularis and capsule which often communicates with cavity of joint. *o*. Occasional bursa between tip of coracoid and capsule of shoulder.

capsular ligament. In addition to the several vessels which run more or less directly to the joint, many twigs from the arteries to the muscles which pass off to it near the insertion of their tendons are connected with the capsule. From the ramifications on the outer side of the capsule, vessels penetrate its substance and in a well injected body can be seen from the inner surface ramifying beneath the synovial membrane. Arterial twigs enter the substance of both bones near the attachment of the capsule (4).

#### BURSAE

There are several bursae in connection with the shoulder joint (Fig. 4).

(1) The subacromial or subdeltoid bursa—the largest and the most frequently brought to the surgeon's attention—is

situated between the tip of the acromion and the capsular ligament below. Morris states that in elderly people this bursa sometimes communicates through a large irregular opening with the synovial cavity of the joint.

(2) Bursa beneath the subscapularis, frequently communicating with the joint cavity.

(3) Bursa upon the capsule and between it and the subscapular tendon.

(4) A small bursa (sometimes absent) on the under surface of the tip of the coracoid process.

(5) An elongated bursa (sometimes absent) between the united coracobrachialis and biceps tendons and the capsular ligament.

(6) Three other bursae not directly placed over the capsule and yet in near relation are: (a) a bursa between the tendon of the teres major and humerus on one side and the upper part of the latissimus dorsi and humerus; (b) a bursa between the tendon of the latissimus dorsi and humerus; (c) a bursa between the tendon of the biceps and humerus. Codman is of the opinion that the subdeltoid, the subacromial, and subcoracoid are one and the same bursa, although they may be separated by films of tissue (2).

#### MUSCLES

In no other joint in the body do muscles play such an important part, not only strengthening the joint but preventing its displacement and at the same time taking a large share in controlling its movements. Four muscles may be said to be inserted into the capsule, while another passes beneath it, acting like a strap to prevent upward as well as lateral displacement and also as a sling to hold the bone against the humerus.

On the outer or extensor side are the supra- and infraspinatus and the teres minor—what some anatomists choose to call the conjoined tendon of the shoulder joint. On the flexor or anterior side, the subscapularis covers the shoulder and the upper and outer side are covered by the

deltoid. The portion of capsule least supported by muscles is the lower or inner side. Here, too, the capsule is the thinnest and there is no projecting bony prominence like the coracoid or acromion to counteract the deficiency of muscular support in bearing pressure of the head of the humerus in states of abduction. Hence abduction, as in the hip, is the position of least safety and the one in which dislocation nearly always occurs

The muscles of the shoulder joint may be grouped according to their action into flexors, extensors, abductors, adductors, and rotators, with the premise, however, that some of them can produce different though not contrary actions in association with other muscles and some combine movement in two directions. Briefly the various groups are as follows:

#### Flexors

Forward movement

Pectoralis major

Anterior fibers of deltoid acting alone

Coracobrachialis

Long and short tendons of biceps

When the arm is raised from the side it is abducted by the subscapularis also

#### Extensors

Latissimus dorsi

Backward movement

Posterior fibers of deltoid acting alone

Infraspinatus (when arm is raised)

Swinging of the arm to and fro is made more free by forward, backward, and rotary movements of the scapula

#### Abductors

Deltoid

Supraspinatus

(Combined use of these muscles raises the arm to a right angle with the trunk. Further elevation is produced by the action of the trapezius upon the scapula and is not a movement of the shoulder joint)

#### Adductors

Forward

Pectoralis major

Coracobrachialis and biceps

Backward

Latissimus dorsi

Teres major and minor

Depressing raised arm may be accomplished either with flexion or extension

The long head of the triceps adducts the arm after it has been abducted

Rotators

Subscapularis

Latissimus dorsi and teres major, to a lesser extent, when arm hangs by side

Teres minor and infraspinatus produce rotation outwards when arm hangs by side

Combined movements

A combination of the four common angular movements—flexion, extension, abduction, and adduction—in quick succession is called circumduction or rotation

PATHOLOGY

Not only are primary joint tumors rare, but a malignant bone tumor seldom invades an adjacent joint. Of 1,000 bone sarcomas seen in the Surgical Pathological Laboratory of Johns Hopkins Hospital and University (6), only 3 involved a neighboring joint. Fibrosarcoma is considered more frequent in the joint capsule than in other regions. The more usual tumors in this location are non-malignant growths derived from precartilaginous or preosseous tissue, such as osteochondroma, ganglion, and giant-cell tumor. Tumors occurring at this site not related to precartilaginous or preosseous tissue are angioma, lymphangioma, lipoma, fibroma, and fibrosarcoma. The two latter, considered rare, are more frequent in the neighborhood of a joint, tendon, or tendon sheath. Berger has reported four cases of synovial sarcoma in bursae.<sup>2</sup>

Razemon and Bizard (5) in 1931 were able to collect from the literature reports of 74 primary joint tumors of which 29 were malignant. Of the 45 benign lesions, 26 were xanthomatous or of the giant-cell variety and 17 were angiomas. One fibroma and one lipoma were recorded. In the malignant group, fibrospindle-cell sarcoma predominated, indicating an origin in the synovial membrane (a type of tumor called capsular sarcoma by Ewing). Other tumors in this group were one chondrosarcoma, 2 myxosarcomas, a liposarcoma, and other sarcomas of which the

histologic type was not further specified. The majority of the malignant tumors recurred or produced metastases. Mention is made of a patient with a recurrent fibrosarcoma treated by amputation and alive twenty-seven months later. Twenty-five sarcomas involved the knee, the remainder the ankle. Osteochondromatosis with free bodies and cysts of the joint cartilage are not mentioned.

In a series of 30 cases listed by Geschickter and Copeland as encountered in the Surgical Pathological Laboratory at Johns Hopkins, there was a single fibrosarcoma. Their list is as follows (6);

Osteochondromas or chondromatosis.....	13
Cartilaginous cysts.....	2
Giant-cell tumors.....	3
Xanthomatous giant-cell tumors.....	5
Lipomas.....	4
Fibroma and fibrospindle-cell sarcoma (1 each).....	2
Hemangioma.....	1
Total.....	30

This represents an incidence of malignancy in joint tumors of a little less than 3.5 per cent, whereas Razemon and Bizard's figure is about 40 per cent.

The difficulty experienced by pathologists in determining the exact origin of a joint tumor calls for some attention. From the gross appearance, fibroma and fibrosarcoma may be difficult to distinguish, and even histologically they may be confused. Whether a tumor is derived from tendon, tendon sheath, a connective-tissue structure in the joint, or the joint capsule, may offer a perplexing problem. Some tumors recorded as sarcomas are actually benign giant-cell tumors erroneously diagnosed (Geschickter and Lewis, 6). A variety of types of sarcoma have been reported (mixed, round-cell, spindle-cell, and endothelial sarcoma) in the bursa, similar to those involving the tendon, tendon sheath, and joint. Traumatic and inflammatory lesions are often difficult to distinguish from these tumors. Collins and Anspach report a case of fibrosarcoma of the plantar tissues which they believe originated in the joint capsule (7). Their

<sup>2</sup> Three of these, designated as endothelial synovial sarcoma, occurred in males 26, 30, and 38 years of age. All three recurred; two led to death, one and two years after onset. Berger believes that these tumors arise from the cells in serous bursae and discusses the details of their origin.

patient was observed over a period of two years before the correct diagnosis was made. Loss of density and cyst-like changes in the bone were the notable roentgen findings. The cyst-like changes were undoubtedly due to small foci of bone destruction similar to areas in the humeral head in the case to be recorded here. It is felt that, when these foci are present, tumor development is already well advanced.

#### CLINICAL PICTURE

Pain, excruciating in character and of increasing severity when the articular bone is involved, loss of function and of motion are the cardinal symptoms of malignant joint tumors. These may continue over a few weeks, months, or even years. With advanced disease, local swelling occurs, and there is marked tenderness. Cyst-like changes in the bone, due to multiple foci of bone destruction, may occur early. Pain even at this time is severe and exaggerated by motion. Metastases may occur early, although in Collins and Anspach's case secondary deposits in the groin and lungs were not discovered until two years after the appearance of the initial symptoms. Fibrosarcoma is considered by pathologists as radioresistant and commonly metastasizes to the lungs. While the tumor remains local, little or no variation from the normal is observed elsewhere in the body.

#### ROENTGEN FINDINGS

Early bone destruction is the notable and important roentgen finding in malignant tumors of the joints. Loss of bone density, obscure trabeculation or its complete absence, a hazy joint space, and thickening of the adjacent soft tissues may offer a clue to the diagnosis. Later, the articular bone surface presents small "cyst-like areas," the size of the head of a pin and larger, due to multiple foci of bone destruction. No evidence of bone repair is observed. In the shoulder the glenoid cavity presents the earliest destructive bone changes and the most extensive, followed by an inflammatory reaction,

involvement of the joint cartilage and of the head of the humerus—the latter in the form of multiple small foci of cyst-like appearance.

#### DIFFERENTIAL DIAGNOSIS

For our purposes, the common diseases of the joints may be considered very briefly from the point of view of differential diagnosis. Such a group must include acute inflammation, tuberculosis, gonorrhea, and that perplexing and elusive group of chronic conditions which are designated by such terms as rheumatoid arthritis, osteo-arthritis, and arthritis deformans. Syphilis of the joint, too, may be added. An acute ankylosing arthritis may simulate the clinical picture of malignant joint tumor (8). Syphilis in the form of Charcot's joint, tuberculosis, and infectious arthritis are too well known to merit further description. They may simulate joint tumor especially in the early destructive stage. Next to roentgen investigation, joint aspiration probably offers the best diagnostic avenue of approach; the presence of malignant tumor cells confirms the clinical impression. If these procedures fail, an exploratory incision followed by biopsy will corroborate the tentative clinical diagnosis.

#### REPORT OF CASE

Mrs. M. A., aged 43 years, was seen June 7, 1942, having been referred by her family physician, who had been treating her for several weeks for a painful shoulder. Her story was as follows:

Pain in the right shoulder began about eight weeks earlier and for the past three or four weeks had been very severe, involving the entire shoulder, radiating down the arm to the elbow. Motion was limited and there was tenderness throughout the shoulder, with some fullness in the anterior and posterior areas. The patient stated that she had felt well up to the onset of the pain. Before this, she had worked hard nursing her son, who was very ill. For the past four weeks, the pain had been extremely severe, continuous, and gnawing in character. She had required sedatives for several nights prior to coming for x-ray examination.

The physical examination, except for the shoulder, was essentially negative. Blood pressure was 180/96. The sedimentation rate showed a 24 mm. drop in one hour, as compared to the normal 1 to 9.

Roentgen examination (stereoscopic, anteropos-

terior), June 11, 1942, revealed an area of bone destruction at the neck of the scapula, invading the glenoid fossa and extending into the base of the coracoid process (Fig. 5). The joint capsule showed invasion and there was surface involvement of the head of the humerus in the form of small punctate areas, the size of the head of a pin and larger. Bone destruction was seen in the spine of the scapula extending within several centimeters of the vertebral border. Because of the extreme pain, roentgenograms could not be obtained in other planes. There was no evidence of disease in the lungs or lumbar spine.



Fig. 5. Fibrosarcoma of the shoulder joint. Note extensive destruction in glenoid cavity and adjacent bone. In the head of the humerus are numerous cyst-like areas which are foci of necrotic bone.

*Diagnosis:* Destructive lesion of shoulder joint. Metastasis, tuberculosis, primary tumor to be considered.

The blood picture (June 7) was as follows: red cells 4,760,000; hemoglobin 85 per cent; white cells 29,800, polymorphonuclears 71, eosinophils 6, lymphocytes 17. On June 13, the white count had risen to 34,300.

The patient was referred to Dr. Edward L. Compere, who on June 13 performed a shoulder girdle amputation followed by several blood transfusions.

The specimen studied consisted of numerous pieces of soft tissue, ranging in color from cream to yellowish cream, and two pieces of bone. One of the latter was saddle-shaped, measuring  $2.0 \times 2.5 \times 1.0$  cm. Its external surface was rough and appeared to be devoid of periosteum; its concave surface presented a moth-eaten surface. Most of bone could be easily crushed. The smaller piece of bone measured 1 cm. in diameter and was of the same consistency as the large piece (Fig. 6).

Sections (Fig. 7) showed a peculiar arrangement of tumor cells in a fibrous stroma, which on low magni-



Fig. 6. Specimen removed at operation (shoulder-girdle amputation). Courtesy Dr. Edward L. Compere.

fication, had a fenestrated appearance. The tumor cells varied considerably in size and the nuclei somewhat resembled fibroblasts. Cytoplasmic limits were often indefinite and in many places there were giant cells. Mitotic figures were numerous. Spicules of dead bone were found in the mass, but there was no evidence of new bone formation. The spaces between the tumor cells resembled fat spaces. A small strip of periosteum showed tumor tissue on both sides. The main tumor growth, however, appeared to be on the inside of the periosteum. An occasional large giant cell had the appearance of a megalokaryocyte, which is further evidence that the tumor probably originated in the marrow cavity.

*Diagnosis:* Atypical fibrosarcoma, probably from the endosteum (Dr. Strauser).

The microscopic sections were submitted to three other pathologists, two of whom have had a large experience with bone tumors. All concurred in the diagnosis and referred to the presence of necrotic bone and inflammatory tissue. A medullary fibrosarcoma of bone was the designation of one; a pleomorphic fibrosarcoma of bone of another. All mentioned the presence of many spindle cells, some giant cells, and numerous mitotic figures in some areas.

The patient was readmitted Sept. 11, 1942, with metastases in the left femur, knee, left side of the neck, and lungs. She died several weeks later. (Patient in service of Dr. E. L. Compere.)

#### COMMENT

The noteworthy features in this case are the acuteness of the symptoms and the rapidity of growth of a destructive tumor of a joint which apparently was well

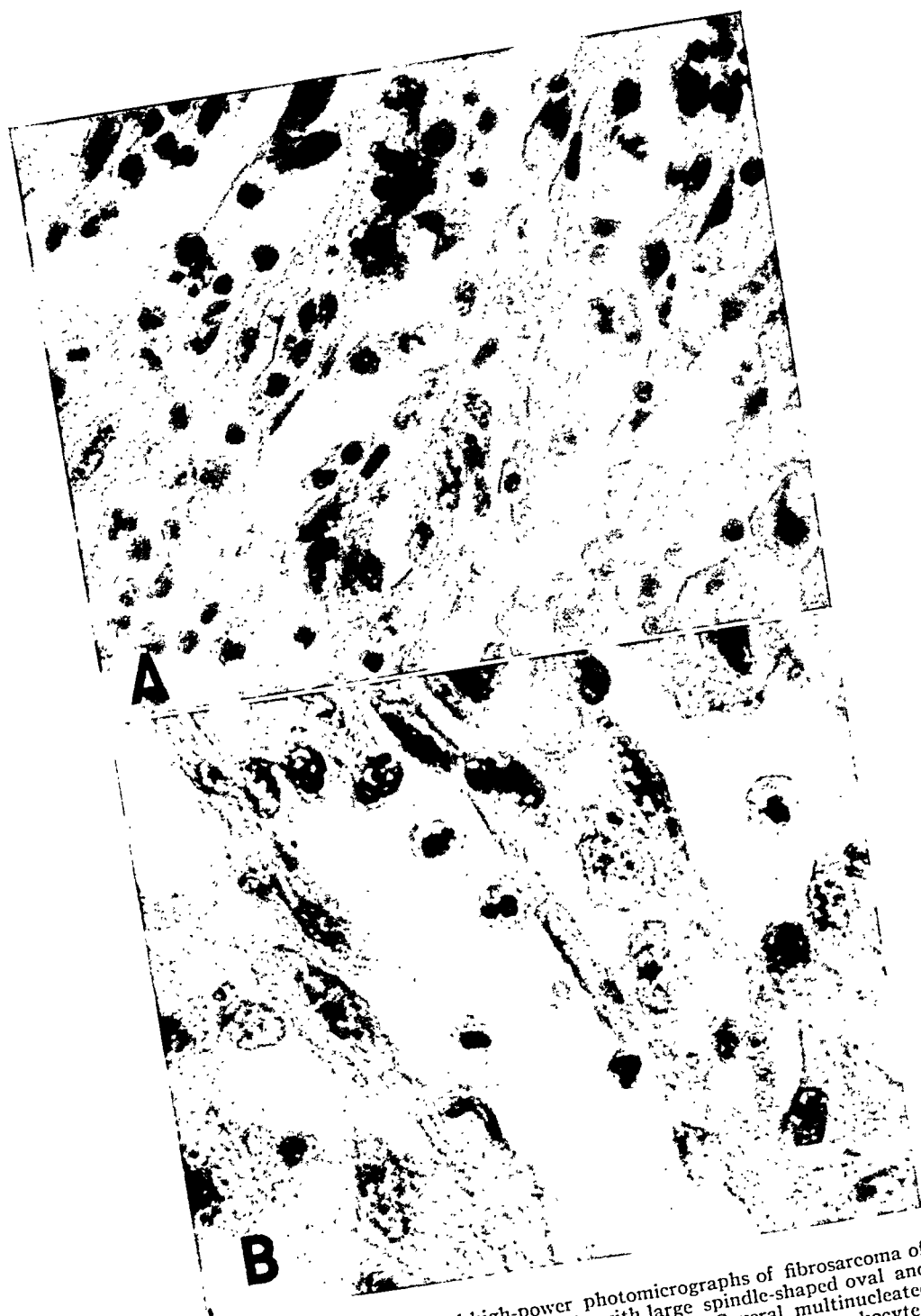


Fig. 7. Low-power and high-power photomicrographs of fibrosarcoma of shoulder joint. Bundles of tumor cells with large spindle-shaped oval and round nuclei are separated by wide blood spaces. Several multinucleated giant cells are present and there is infiltration of polymorphonuclear leukocytes. The nuclei in some of the multinucleated cells are rich in chromatin.

advanced when the patient was first seen by her family physician. A high degree of malignancy is established by the concordance of opinion of all the pathologists consulted. Since the roentgen examination revealed marked surface destruction of the glenoid cavity, haziness of the joint surfaces, and small cyst-like areas of bone destruction in the head of the humerus (the tumor evidently beginning to cross the joint), the possibility of a metastatic growth arises. Certainly tumor cells were present beyond the site of origin. Since the destruction was greatest in the glenoid cavity, it is fair to assume that the tumor may have originated there, either in the synovial membrane or in the endosteum, as indicated by one of the pathologists.

Pathologists have frequently remarked that this type of tumor is radioresistant. Collins and Anspach's patient responded remarkably well to irradiation, even though the symptoms at the time of treatment were of two years' duration. It is purely conjectural what effect roentgen therapy would have had in this case.

#### CONCLUSIONS

Primary joint tumors are rare and malignant tumors are rarer still. The anatomy and physiology of the shoulder joint are presented here in some detail with the idea that their consideration may be of some aid in the interpretation of the origin of a tumor, when the pathological and other data are carefully analyzed. The structures which enter into the formation of a joint are the articular surfaces of bone covered by hyaline cartilage, the epiphysis, in some cases the epiphyseal cartilage and metaphysis and the synovial membrane. Added to these are the many bursae in the shoulder joint, some of which connect with the synovial cavity. The exact origin of a sarcoma may be difficult for a pathologist to determine, but the source of tissue not related to precartilaginous or

preosseous tissue varies widely, from the bursa to the synovial membrane. Inflammatory conditions induced by trauma, to which the shoulder joint is especially subject, may be a contributing etiologic factor.

A case is presented of fibrosarcoma of the shoulder joint, with symptoms of eight weeks' duration. Early bone destruction of the glenoid cavity, a hazy joint space, and multiple small foci of bone destruction in the head of the humerus were the important roentgen findings. A shoulder girdle amputation was performed. Metastases in the lungs, femur, and neck were present three months later. Death occurred about fourteen weeks after operation.

NOTE: I am greatly indebted to Dr. Gouwens for the privilege of using the clinical material and to Dr. Edward L. Compere, who kindly furnished a photograph of the specimen and other aid. I also wish to thank Dr. Strauser for several microscopic slides and his interpretation, and Dr. A. C. Strunk and Melvin H. Battenberg for their patience in securing satisfactory photomicrographs for reproduction.

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#### BIBLIOGRAPHY

1. GESCHICKTER, CHAS. F., AND COPELAND, M. M.: Tumors of Bone. Published by Am. J. Cancer, New York, 2d ed., 1936.
2. CODMAN, E. A.: The Shoulder, Rupture of the Supraspinatus Tendon and Other Lesions in or about the Subacromial Bursa. Boston, Thomas Todd Co., 1934.
3. BOYD, W. M.: Surgical Pathology. Philadelphia, W. B. Saunders Co., 5th ed., 1942.
4. MORRIS, HENRY: Anatomy of the Joints of Man. Philadelphia, Lindsay & Blakiston, 1879.
5. RAZEMON, P., AND BIZARD, G.: Les tumeurs primitives des articulations. *Rev. de chir.* 50: 229-266, 1931.
6. GESCHICKTER, C. F., AND LEWIS, DEAN: Tumors of Tendon Sheaths, Joints, and Bursae. *Am. J. Cancer* 22: 96-126, 1934.
7. COLLINS, N. C., AND ANSPACH, W. E.: Fibrosarcoma of Plantar Tissues. *Am. J. Cancer* 40: 465-470, 1940.
8. OLIN, HARRY A.: Acute Ankylosing Arthritis. *Radiology* 26: 717-728, 1940.
9. BERGER, L.: Synovial Sarcomas in Serous Bursae and Tendon Sheaths. *Am. J. Cancer* 34: 501-539, 1938.



# Nomographic Aids in Calculating Radium Dosage for Plane and Point Sources<sup>1</sup>

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CALCULATIONS of radium dosage were considerably simplified by the contributions of Paterson and Parker (1, 2). For radium sources, filtered by 0.5 mm. Pt or its equivalent, distributed on square or circular areas, the number of milligram hours required to deliver 1,000 gamma roentgens could be determined from a group of graphs. The same data can be put in the form of an alignment chart or nomogram. The advantages of a nomogram are that it is compact and that no interpolation is required in order to obtain intermediate values. With very little practice, nomograms can be used with facility and speed.

The nomogram (Fig. 1) presented for this purpose consists of three vertical scales. On the left-hand scale is found the area in square centimeters. On the scale in the center is found the treatment distance in centimeters. The right-hand scale has divisions on both sides. The divisions on the right side of this scale are labeled at the top "Mg. Hrs."; the divisions on the left side of this scale are labeled at the top "%."

To find the number of milligram hours required to deliver 1,000 gamma roentgens, one finds the area on the left-hand scale and the treatment distance on the scale in the center. Then, a straight edge, *e.g.*, a ruler, preferably transparent, is placed across the chart through the points selected on these two scales. The straight edge intersects the right-hand scale at a certain point. The figures on the right side of this scale give the same result as the Paterson and Parker area graphs but expressed per square centimeter. When this figure is multiplied by the area, the number of milligram hours required to deliver 1,000

gamma roentgens is obtained. For filtration equivalents other than 0.5 mm. Pt, the Paterson and Parker correction figures are used (Table I). The figures on the left-hand side of the third scale are discussed below.

TABLE I: FILTRATION CORRECTION FACTORS FOR RADIATING AREAS, AFTER PATERSON AND PARKER

Thickness, mm. Pt	0.3	0.5	0.8	1.0	1.5	2.0
Multiply hr. by	95%	100%	105%	110%	120%	135%

Gold: As platinum.  
Lead and Silver: As half their thickness in platinum.  
Monel, Brass, Steel: As one-quarter their thickness in platinum.

For square areas, Paterson and Parker gave definite distribution rules specifying the amount of radium to be placed on lines added within the square separated by twice the treatment distance. Unfortunately, the exact linear strengths and lengths that these rules require are rarely available. It usually turns out that the figure of practical importance is the percentage of the total amount of radium that must be placed on the lines added within the square. The figures on the left-hand side of the third scale, labeled at the top "%," are these percentages, *i.e.*, they give the percentage of the total amount of radium that must be placed within the periphery of a square. These figures apply when more than one line is added. If only one line is added, the percentage is always 11 per cent.

These percentage figures may also be used for rectangular areas up to the point at which one side is twice as long as the other. Corrections for more elongated rectangles are given in Table II. These figures for rectangles apply when more than one line is added. If only one line is added, and one side of the rectangle is at least

<sup>1</sup>From the Department of Radiotherapy, The Mount Sinai Hospital, New York, N. Y. Accepted for publication in September 1943.

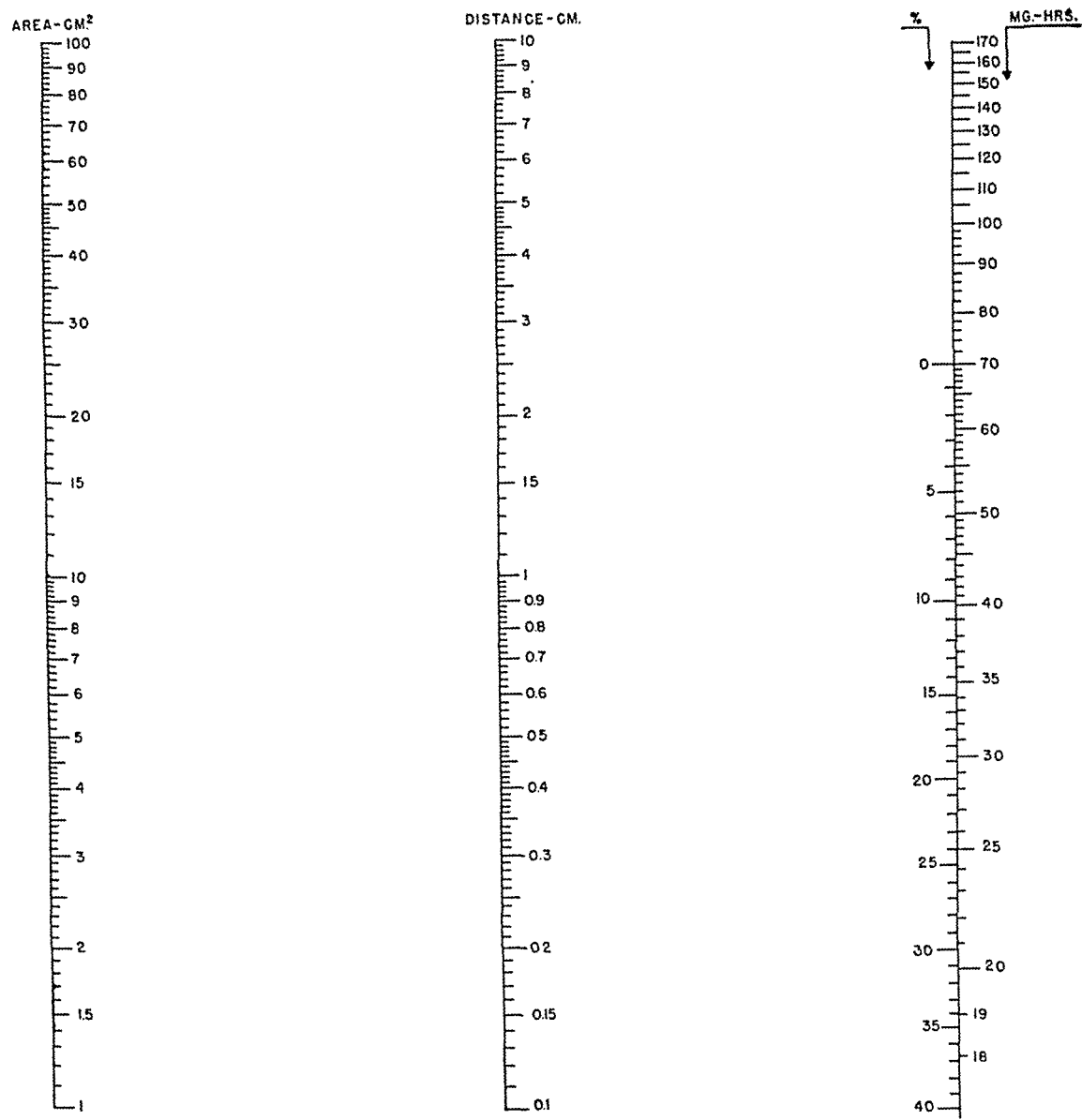


Fig. 1. Nomogram to calculate dosage for radium sources distributed on square and circular areas. For explanation, see text.

twice the other, the percentage is 15 per cent.

TABLE II: ELONGATION CORRECTION FACTORS FOR PERCENTAGES OF RADIUM TO BE CENTRALLY PLACED (Sides of rectangle are *a* and *b*)

Elongation Subtract	<i>b</i> = 2 <i>a</i> 5%	<i>b</i> = 3 <i>a</i> 9%	<i>b</i> = 4 <i>a</i> 12%
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The percentage figure in the nomogram gives the amount of radium which must be placed on the central lines as the percentage of the *total* amount of radium. It is sometimes more useful to express the amount of

central radium required as a percentage of the radium on the *periphery* (abbreviated “% of peripheral radium”) rather than as a percentage of the total radium (which includes both the peripheral and central radium). These two percentages are related by a simple formula:

$$\% \text{ of peripheral radium} = \frac{\% \text{ of total radium}}{1 - \frac{\% \text{ of total radium}}{100}}$$

The figures for milligram hours may also be used for areas in the shape of equilateral triangles, with the following rules of distribution:

(1) When the ratio of the side of the triangle to the treatment distance is no greater than 4, no additional central radium is required.

(2) When this ratio is greater than 4 but not greater than 8, 10 per cent of the total amount of radium should be centrally placed.

An example for a rectangular area will illustrate how the nomogram and correction factors are used.

the radium capsules. The thickness of this material must then be measured, and it may turn out to be not exactly 0.5 cm. but, e.g., 0.6 cm. With the nomogram, the calculation is equally easy with either of these two thicknesses. (This is not true of the Parker graphs.) Let us assume that it turns out to be 0.6 cm.

We now have determined the exact area (8.8 sq. cm.) and treatment distance (0.6 cm.) to be used. By placing a straight edge on the nomogram through 8.8 on the left-hand scale and 0.6 on the center scale (Fig. 2), we find from the right-hand scale that 28.1 mg. hr. are required per square

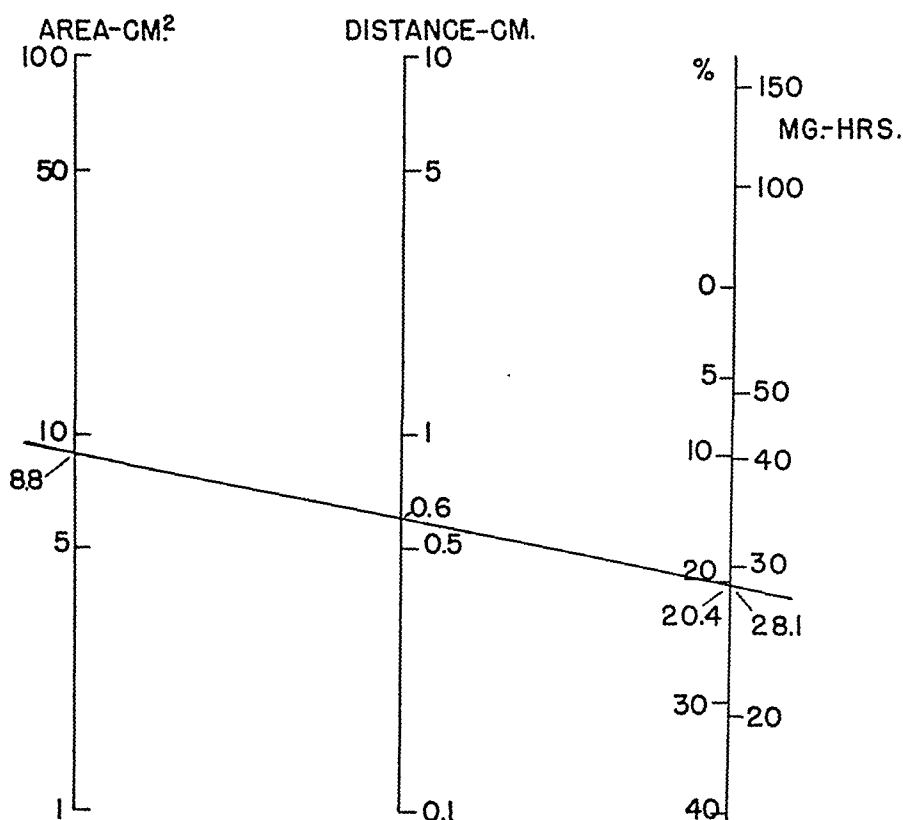


Fig. 2. Example of use of nomogram. A straight edge through 8.8 on the left-hand scale and 0.6 on the center scale intersects the right-hand scale at 28.1 mg. hr. and 20.4 per cent.

EXAMPLE: Assume a limited supply of 10- and 15-mg. radium capsules with filtration equivalent to 1.0 mm. Pt, 2.2 cm. over-all length, and 1.8 cm. active length. It has been decided to treat an area on the skin approximately 4 by 2 cm. by a plaque at about 0.5 cm. from the skin and the dose desired is 3,000 gamma roentgens.

With capsules of these dimensions, an area exactly 4 by 2 cm. cannot be obtained without overlapping the ends. This is undesirable because portions of the capsules are then at different distances from the skin. To avoid this, the area treated is made 4.4 by 2 cm. A slab of wax or dental compound of suitable dimensions is selected to carry

centimeter to deliver 1,000 gamma roentgens (if filtration were 0.5 mm. Pt and the area square). Since the area is a 2:1 rectangle, 5 per cent must be added to the number of milligram hours (Table II). Since filtration is 1.0 mm. Pt, an additional 10 per cent must be added (Table I).

115% of 28.1 = 32.4 mg. hr. per sq. cm.  
 $32.4 \times 8.8 = 285$  mg. hr. to deliver 1,000 gamma roentgens.  
 $285 \times 3 = 855$  mg. hr. to deliver 3,000 gamma roentgens.

Also, from the scale labeled "%," we find that 20.4 per cent of the total amount of radium should

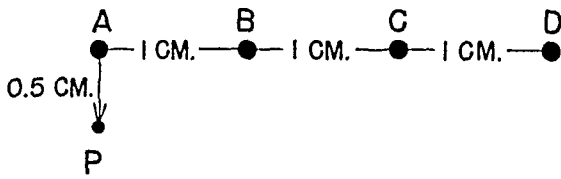


Fig. 3. Point sources in a single row. To find the dose at *P*, the distance from each point source to *P* must be calculated and then substituted in the inverse square formula.

be placed within the periphery (if the area were square). Since the area is a 2:1 rectangle, 5 per cent must be subtracted from this percentage (Table II):

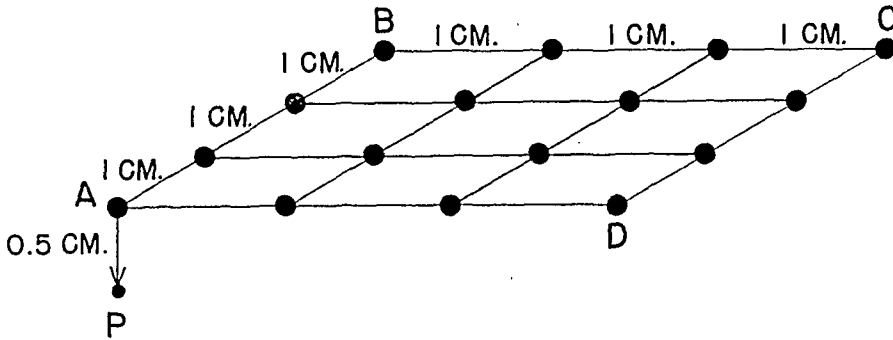


Fig. 4. Point sources in several rows. To find the dose at *P*, the distance from each point source to *P* must be calculated and then substituted in the inverse square formula.

20.4% - 5% = 15.4% of the total amount of radium is to be placed within the periphery.  
% of peripheral radium to be centrally placed  
$$= \frac{15.4}{1 - \frac{15.4}{100}} = \frac{15.4}{1 - 0.154} = \frac{15.4}{0.846} = 18.4$$
  
or, with sufficient accuracy, 18%.

We may place 15-mg. capsules in the periphery, two for each long side and one for each short side. This gives 90 mg. in the periphery. We desire 18 per cent of 90, or 16 mg. along a center line. The best we can do with the radium supply available is to place a single 15-mg. capsule in the center. Total number of milligrams in the plaque will then be 105 and the time required will be 855 divided by 105, or 8 hours and 9 minutes.

The distribution of the linear radium sources on the plaque finally used deviates considerably from a perfect Paterson and Parker distribution. In order to determine how great the difference is at any point, it is necessary to calculate the dose at that point from each linear source separately. Data have been given in a previous publication (3) which simplify this type of calculation.

Calculation of dosage "in air" from point sources of radium element or emanation, though theoretically simple, is frequently quite tedious. The reasons for this are that point sources are usually multiple and the formulae which must be used in the calculation are arithmetically rather cumbersome. It becomes necessary to calculate the distance from each source to the point at which the dose is to be calculated and then substitute this distance in the inverse-square formula. If the filtration is

0.5 mm. Pt, and the figure 8.4 is taken as the number of gamma roentgens from a 1-mg. point source of radium element in 1 hour at 1 cm., the inverse-square law may be written:

Dose in gamma roentgens per milligram hour  
$$= \frac{8.4}{\text{distance}^2}$$

The various distances are calculated from the Pythagorean formula

$$\text{Distance}^2 = X^2 + Y^2 \tag{1}$$

if all the points concerned (including the point at which the dose is to be calculated) lie in the same plane; or from the formula

$$\text{Distance}^2 = X^2 + Y^2 + Z^2 \tag{2}$$

if all the points do not lie in the same plane. It is easiest to explain what *X*, *Y*, and *Z* represent by two short examples.

EXAMPLE 1 (Fig. 3): Suppose that four point sources were used in a line, separated from each other by 1 cm., and that we desire to calculate the

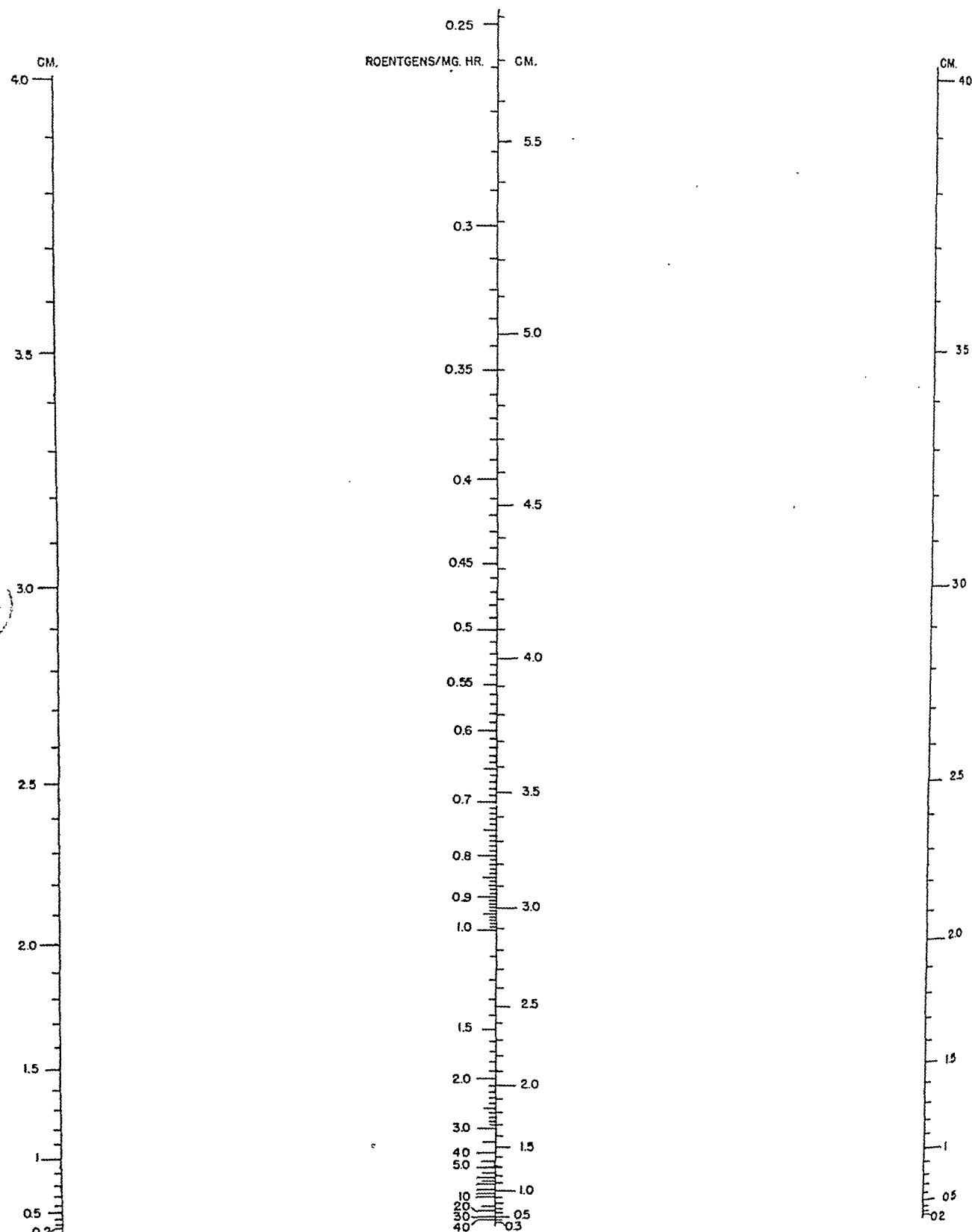


Fig. 5. Nomogram to calculate dosage from point sources. For explanation, see text.

dose per milligram hour at  $P$  from the point source at  $D$ , filtration 0.5 mm. Pt.

The distance from  $D$  to  $P$  or  $DP$  is calculated from the known distance  $AD$  ( $= 3 \times 1 \text{ cm.} = 3 \text{ cm.}$ ) and the known distance  $AP$  ( $= 0.5 \text{ cm.}$ ).

The distances  $AD$  and  $AP$  are represented by  $X$  and  $Y$  in the general formula (1).

$$\begin{aligned}\text{Distance}^2 &= X^2 + Y^2 \\ DP^2 &= AD^2 + AP^2 \\ DP^2 &= 3^2 + 0.5^2 = 9.25 \\ DP &= 3.2 \text{ cm.}\end{aligned}$$

Dose per milligram hour  $= \frac{8.4}{DP^2} = \frac{8.4}{9.25} = 0.91$   
gamma roentgen.

In the same way, it is easily found that the dose per milligram hour from a point source at  $A$  is 33.6; from  $B$ , 6.7; from  $C$ , 1.98 gamma roentgens. The dose at point  $P$  for 4 mg. hr. would then be the sum of the four figures, or 43.2 gamma roentgens if the radium is equally distributed at the points  $A, B, C$ , and  $D$ .

EXAMPLE 2 (Fig. 4): Suppose that sixteen point sources were used on four lines, separated from each other by 1 cm., the four point sources on each line being also placed 1 cm. from each other. We desire to calculate the dose per milligram hour at  $P$  from the point source at  $C$ , filtration 0.5 mm. Pt.

The distance from  $C$  to  $P$  or  $CP$  is calculated from the known distances  $BC$  ( $= 3 \times 1 \text{ cm.} = 3 \text{ cm.}$ ),  $AB$  ( $= 3 \times 1 \text{ cm.} = 3 \text{ cm.}$ ), and  $AP$  ( $= 0.5 \text{ cm.}$ ). These distances are represented by  $X$ ,  $Y$ , and  $Z$  in the general formula (2).

$$\begin{aligned}\text{Distance}^2 &= X^2 + Y^2 + Z^2 \\ CP^2 &= BC^2 + AB^2 + AP^2 \\ CP &= 4.27\end{aligned}$$

Dose per milligram hour  $= \frac{8.4}{CP^2} = \frac{8.4}{18.25} = 0.46$   
gamma roentgen.

To shorten the time required for these calculations, a nomogram (Fig. 5) and an auxiliary scale (Fig. 6) are presented.

The nomogram consists of three vertical scales. The scale in the center and the auxiliary scale are used independently of the two outer scales of the nomogram when the distance is known without further calculation, as for a single point source. Then one simply finds the distance on the right side of one of these scales and reads on the left side the dose per milligram hour in gamma roentgens. The auxiliary scale is necessary to cover the range of short distances with accuracy. It would seem at

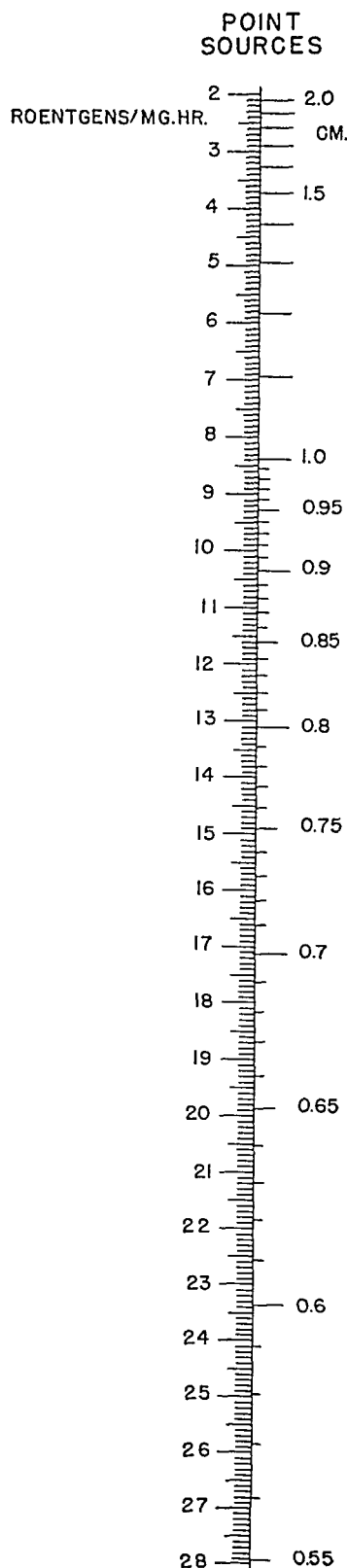


Fig. 6. Auxiliary scale to calculate dosage from point sources.

TABLE III: FILTRATION CORRECTION FACTORS FOR POINT SOURCES ACCORDING TO LAURENCE

Thickness, mm. Pt	0.3	0.5	0.8	1.0	1.5	2.0
Multiply roentgens by	103%	100%	97%	94%	87%	82%

first sight that the largest distance included in these two scales is 5.8 cm. and that one could not obtain the dose if the distance, e.g., was 6 cm. This difficulty is easily overcome by using multiples of 10. For example, the dose at 6 cm. is simply one-hundredth of the dose at 0.6 cm. and the dose at 0.6 cm. can be found on the auxiliary scale without difficulty.

edge. The point thus found on the central scale gives the dose.

For filtrations other than those equivalent to 0.5 mm. Pt, correction factors must be applied. These factors, calculated from data of Laurence (4, 5), are given in Table III. These are not the same factors used for linear or plane sources.

When the radiating source is surrounded by tissue, corrections for tissue absorption must be used. Average correction figures were calculated by Laurence (4, 5) and are given in Table IV.

The above data are based on the assumption

TABLE IV: CORRECTION FACTORS FOR TISSUE ABSORPTION ACCORDING TO LAURENCE

Thickness of tissue, cm.	1	2	5	7	9	12	14	16	18	20
Multiply roentgens by	98%	95%	92%	89%	85%	80%	76%	73%	70%	67%

When the distance is not known directly but must be calculated from two known distances  $X$  and  $Y$ , as in Example 1 above, then the full nomogram is used. One finds  $X$  on the left-hand scale of the nomogram and  $Y$  on the right-hand scale and connects these two points by a straight edge. This straight edge intersects the central scale at a point which gives the dose (and incidentally the distance).

When the distance must be calculated from three known distances,  $X$ ,  $Y$ , and  $Z$ , as in Example 2, the nomogram must be used twice. First, one connects  $X$  and  $Y$ , as in the previous case, but reads off from the central scale, not the dose, but the distance. Then, this distance is found on the left-hand outer scale and joined to  $Z$  on the right-hand outer scale by a straight

tion that the radiating source is actually a point. This is clearly not true of any source in actual practice. The dose as calculated is therefore a little high. In the average case, however, this error does not exceed 5 per cent.

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BIBLIOGRAPHY

1. PATERSON, R., AND PARKER, H. M.: Dosage System for Gamma Ray Therapy. Brit. J. Radiol. 7: 592-632, October 1934.
2. PATERSON, R., AND PARKER, H. M.: Dosage System for Interstitial Radium Therapy. Brit. J. Radiol. 11: 252-266, April 1938.
3. WOLF, B. S.: Radium Dosage for Linear Sources. Am. J. Roentgenol. 50: 400-405, September 1943.
4. LAURENCE, G. C.: Radium Dosage. National Research Council of Canada, Bulletin No. 17, 1936.
5. LAURENCE, G. C.: Intensity and Dosage near Radium Needles. Radiology 25: 166-181, August 1935. (Correction 25: 635, November 1935).

# Roentgen Detection in an Army General Hospital of Chronic Diseases Not Excluded by Induction Boards<sup>1</sup>

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ROENTGEN EXAMINATION for excluding from the armed services selectees with pulmonary tuberculosis has proved invaluable. Two years of experience in an army general hospital has confirmed this fact and has in addition convinced the writer that x-rays have not been employed to greatest advantage in the initial examination of other systems of the body. The purpose of this paper is to present material in support of this conviction.

The O'Reilly General Hospital is now a 2,200-bed institution serving the entire Seventh Service Command; patients are also received from all theaters of operation for treatment and disposition. During the first year of operation, the patients consisted largely of recently inducted enlisted men who were having difficulty in adjustment to army routine because of mental and physical disturbances which had existed prior to induction. Many were adjusted satisfactorily in civilian life; but the abrupt change, the mental and physical strain, and the rugged discipline resulted in an exacerbation or intensification of symptoms. With the onset of hostilities following the attack on Pearl Harbor, battle casualties were admitted. Though casualty admissions now greatly exceed those from the zone of the interior and communications, the soldier-patient with disease antedating induction continues an important problem of disposal.

## MATERIAL

This study covers approximately 9,000 military admissions from Nov. 1, 1941, to June 1, 1943. It is estimated that about 80 per cent were recent inductees. The diseases of roentgen interest encountered were bronchiectasis, urinary calculi, post-

traumatic brain atrophy, herniated disk, spondylolisthesis, colitis, and peptic ulcer. The gastro-intestinal disorders have been found to be second in importance to the neuropsychiatric diseases in this hospital

## BRONCHIECTASIS

The diagnosis of bronchiectasis is difficult from the ordinary plain film; it can be made with certainty only upon the demonstration of dilated bronchi by means of an opaque solution. Occasionally one may find a "honeycomb" appearance typical of advanced disease, but this is not the rule. A negative chest film and a history of a persistent productive cough warrant a study with iodized oil. Only by this means can early lesions be detected. There were 30 patients with bronchiectasis in the series under consideration; in 24, or 80 per cent, the disease antedated entrance into the army (Table I). These men had an average length of service of six months. In 22, or 91 per cent of the 24, the lesions were demonstrable by lipiodol study.

## URINARY CALCULI

Urinary calculi, if they are opaque to the roentgen ray, are easily visible on the routine flat film of the abdomen. Renal and bladder stones are often silent; if not, the symptoms may be mild and cause no undue disturbance. It is not too difficult to conceive of the physical activity peculiar to the army aggravating or actually initiating colic. A flat film of the abdomen is indicated where a history of abdominal pain or renal or ureteral colic is elicited. There were 37 patients in the series with calculi; this diagnosis was primary in 29. In 24, or 83 per cent of the 29, symptoms were present before induction. Two-thirds of these men, with an average length of service of eight

<sup>1</sup> From the Radiological Service of the O'Reilly General Hospital, Springfield, Missouri. Read by title at the Twenty-ninth Annual Meeting of the Radiological Society of North America, Chicago, Ill., Dec. 1-2, 1943.



TABLE I: BRONCHIECTASIS AND URINARY CALCULI. COMPARATIVE STATISTICS FOR PATIENTS WITH LINE OF DUTY STATUS YES AND THOSE WITH SYMPTOMS PRIOR TO INDUCTION

	Bronchiectasis	Urinary Calculi
Number	30	29
Existed prior to induction or enlistment	24 (80%)	24 (83%)
X-ray positive	22 (91%)	...
Length of service (av.)	6 months (1-29 months)	8 months (1-31 months)
Discharged	24 (100%)	16 (66%)
Line of duty status yes	6 (20%)	5 (17%)
X-ray positive	6 (100%)	...
Length of service (av.)	5 years (4 months-24 years)	2 years (7 months-4 years)

months, were given a medical discharge (Table I).

POST-TRAUMATIC HEAD SYNDROME

The severity of an injury incurred several or more years prior to military service is not appreciated without careful and pointed questioning, which has not been possible during induction examination. Therefore, the necessity arises for the use of key questions. This is particularly true for injuries to the head and spinal column, in which sequelae are apt to be frequent and serious, yet not apparent during the brief period of investigation. These cerebral and spinal column disorders comprised a large group in our study. The majority of the men were so handicapped that a medical discharge resulted. Such roentgen diagnostic methods as encephalography and myelography were not employed in many in whom the symptoms preceded induction and in whom the diagnosis was obvious clinically. These procedures, however, were utilized more freely in those whose injury was incurred in line of duty.

Of 78 patients with a post-traumatic head syndrome, 41, or 53 per cent, stated that its onset was in civilian life (Table II). Of the 15 in whom encephalographic studies were made, 12 (80 per cent) showed evidence of atrophy. On the other hand, this change was found in only one-third

of those examined in line of duty. Thus 23 per cent of the total number of patients with post-traumatic head syndrome gave positive findings. The true figure is no doubt higher, since, as stated above, encephalograms were not made in all cases.

NUCLEUS PULPOSUS

The syndrome resulting from a rupture of the annulus fibrosus is characteristic enough so that a clinical diagnosis is possible in over 90 per cent of all cases. Roentgen methods are as accurate, but it must be cautioned that in a small percentage opaque studies will fail to disclose a herniation. An opaque medium is invaluable where pressure on the nerve is absent, when symptoms are vague, and when the question of a neoplasm arises. In our early examinations we employed air or lipiodol. All our recent lumbar injections have been done with panto-paque, which was easily and completely withdrawn immediately following the termination of the examination. No unpleasant after effects were noted. Of 114 men in whom the diagnosis was made, 79, or 70 per cent, had symptoms antedating induction (Table II). Of these, 76, or 96 per cent, were discharged. The average length of service was seven months.

SPONDYLOLISTHESIS

Spondylolisthesis is easily diagnosed on routine films of the lumbar spine. Of the 18 men in whom this diagnosis was made, 16, or 89 per cent, had an average length of service of seven months (Table II). All were discharged. The remaining 2 had five and six years of service and were not discharged, though it was recognized that the defect existed prior to enlistment.

PEPTIC ULCER

Chronic disease of the digestive tract is the second largest cause of permanent invalidism at this hospital. Schindler (1) stated in March of 1942 that chronic ulcer would certainly be one of the most common diseases in the army. British

TABLE II: POST-TRAUMATIC HEAD SYNDROME, HERNIATED NUCLEUS PULPOSUS, SPONDYLOLISTHESIS. COMPARATIVE STATISTICS FOR PATIENTS WITH LINE OF DUTY STATUS YES AND THOSE WITH SYMPTOMS PRIOR TO INDUCTION

	Post-Traumatic Head Syndrome	Nucleus Pulposus	Spondylolisthesis
Number	78	114	18
Existed prior to induction or enlistment	41 (53%)	79 (70%)	16 (89%)
X-ray examination	15	4	....
X-ray positive	12 (80%)	2	....
Length of service (av.) 9 months (1-24 months)		7 months (1-30 months)	7 months (1-15 months)
Discharged	40 (98%)	76 (96%)	16 (89%)
Line of duty yes	37 (47%)	35 (30%)	....
X-ray examination	18	16	....
X-ray positive	6 (33%)	14 (88%)	....
Length of service (av.) 2.5 years (4 months-24 years)		2.5 years (2 months-18 years)	....
Discharged	27 (73%)	....	....

authors are agreed that dyspepsia constitutes for them the major medical problem of this war. Thus it is evident that the immediate recognition of such cases and their proper disposition will avert much confusion, dissatisfaction, and injustice when the war is over. The draft and induction boards can, with the aid of specialists and facilities in the increased

or gastric ulcers, is not so high as that given by Tidy (2), who showed that of 2,500 consecutive military patients with dyspepsia admitted to various hospitals in England, 51.9 per cent had peptic ulcers. If dyspepsia had been included in the series reported here, it is reasonable to assume that a closer approximation would have been obtained. There were only 12

TABLE III: DUODENAL AND GASTRIC ULCER AND COLITIS. COMPARATIVE STATISTICS FOR PATIENTS WITH LINE OF DUTY STATUS YES AND THOSE WITH SYMPTOMS PRIOR TO INDUCTION

	Duodenal Ulcers	Gastric Ulcers	Colitis
Number	215	12	31
X-ray positive	181 (84%)*	12 (100%)	9 (40%)†
Existed prior to induction or enlistment	165 (77%)	5 (42%)	23 (74%)
Crater	41 (30%)	....	....
Deformity	98 (70%)	....	....
Average length of service	7.5 months (2 days-32 months)	9 months (2-32 months)	10 months (1-23 months)
Discharged	165 (100%)	5 (100%)	23 (100%)
Line of Duty Yes	50 (23%)	7 (58%)	8 (26%)
Crater	9 (21%)	....	....
Deformity	33 (79%)	....	....
Average length of service	8 years (5 months-28 years)	13 years (11 months-21 years)	1 year (8 months-2 years)
Discharged	45 (90%)	2 (29%)	....

\* The remainder had positive findings at transfer station and were healed or gave typical story without demonstrable crater or deformity.

† That is, 40 per cent of those in whom the disease existed prior to induction.

number of army hospitals, now eliminate not only those with active and quiescent ulcers but also the recruit with a psychoneurotic tendency in whom ulcers are prone to develop.

There were 542 admissions of enlisted men to the gastro-intestinal ward; 215, or 40 per cent, had duodenal ulcers (Table III). This figure of 40 per cent, which does not include duodenal ulcers in officers

benign gastric ulcers; curiously enough none was seen in the officer group. Our ratio of duodenal to gastric ulcers is 18 to 1, which corresponds exactly to that given by Flood (3). Only 77 per cent of our patients had symptoms prior to induction, which is lower than the 93 per cent of Flood (3) and 90 per cent estimated by Hurst (4) and Tidy (2) independently. Our recent inductees had an average length

of service of 7.5 months and all, without exception, were discharged. The high incidence (70 per cent) of deformity (Table III) is noteworthy in that it indicates the presence of long-standing chronic disease in the majority of those recently enlisted. More craters might have been demonstrable had a compression spot device been available.

#### COLITIS

Colitis is a disabling disease. The chronic ulcerative type is permanently disabling. Of 31 cases, 23, or 74 per cent, were classified as having existed prior to induction; the average length of service was ten months (Table III). Nine, or 40 per cent, of the patients showed roentgen evidence of ulceration. Three were so ill they could not be examined. All of the recently inducted patients were discharged but one, who died.

#### COMMENT

A summation of statistics for the disease entities described shows that 71 per cent existed prior to induction; that the average length of service in patients with preinduction disease was eight months; that of these, 94 per cent were given a certificate of disability discharge. Thus, it is obvious that more than two-thirds of the enlisted patients with these chronic ailments, which are amenable to x-ray diagnosis, had the disease in civilian life. Over 90 per cent were subsequently discharged back to civilian status. The average length of service of eight months is not considered long enough for the development of a trained soldier. Moreover, it is hardly likely that during this period efficient or satisfactory duty was possible.

Why have these men escaped detection by the examining boards? There are several reasons. Some men failed to mention their symptoms because they were not questioned about them specifically. Others failed to mention them because they were in a state of remission or because they were not considered serious. This was es-

pecially true of many with ulcers, who interpreted their difficulty simply as indigestion. Many enumerated their symptoms, but these were not believed to be significant by the examiners and therefore not investigated. Perhaps the greatest handicap has been the lack of time available to the medical boards for the taking of adequate histories. This is important, since the type of specialized examination to be performed is most dependent upon the history. Any effort to improve the accuracy of selections will be valueless unless this fact is recognized.

The experience acquired since November 1940 should be applied, since new manpower is continually necessary for replacement and expansion. The establishment of a larger peacetime army and the possibility of compulsory conscription in the future will require more careful sorting of recruits. This can be materially aided by the use of an objective method such as roentgen examination. Many well equipped army hospitals have been built where roentgen procedures can be satisfactorily accomplished if civilian facilities are not available. The formation of specially trained and experienced medical teams may also be indicated. More credence and emphasis will have to be placed on the history of cough, digestive complaints, abdominal and back pain, and injury to the head and spinal column with subsequent pain on activity. Certainly the time expended in special procedures will not approximate the ineffective eight months spent in the service and the expense of hospital care and observation required before discharge.

#### SUMMARY

1. Experience in an army general hospital has shown that draft and induction boards have failed to detect many chronic diseases which with a more careful screening process could have been excluded.

2. These diseases are bronchiectasis, urinary calculi, post-traumatic brain atrophy, herniated intervertebral disk,

spondylolisthesis, duodenal and gastric ulcer, and colitis.

3. The taking of an adequate and careful history is essential. More attention must be given to such symptoms as cough, injuries to the head and spinal column with subsequent pain on activity, and indigestion.

4. The wide application of specialized x-ray procedures, such as bronchography, intravenous urography, encephalography, myelography, gastro-intestinal series, and barium enema studies may be justified only when performed by trained personnel,

since any accompanying risk is practically negligible.

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#### REFERENCES

1. SCHINDLER, RUDOLF: Gastroenterology in the Army: Methods of Examination and Disposition of Cases. *War Medicine* 2: 263-276, March 1942.
2. TIDY, H. L.: Dyspepsia in the Forces. *J. Roy. Army M. Corps* 77: 113-122, September 1941.
3. FLOOD, CHARLES A.: Peptic Ulcer at Fort George G. Mead, Md. *War Medicine* 3: 160-170, February 1943.
4. HURST, A.: Digestive Disorders in Soldiers. *Am. J. Digest. Dis.* 8: 321-323, September 1941.

# Value of the Delayed Examination in Pyelography<sup>1</sup>

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WHEN THE URINARY tract is investigated by retrograde pyelography, additional roentgenograms made subsequent to the usual routine can be of great value. In the presence of a retentive hydronephrotic kidney, for example, roentgenograms made as late as twenty-four hours after the pyelogram have suggested the nature of the lesion.



Fig. 1. Roentgenogram made immediately after the injection of 20 c.c. of skiiodan. The large kidney mass can be seen readily. The opaque medium fills the right ureter and a portion of the upper pole of the kidney. The dye in the kidney is ill defined and was thought to be loculated.

M. L., white female, age 81, was admitted with a history of right lower quadrant pain radiating to the back. The first episode had occurred three weeks before admission and was accompanied by mild abdominal distention. The symptoms subsided in a few days, recurring on the day of admission.

The possibility of an intestinal obstruction was



Fig. 2. Same case as Fig. 1: Examination twenty-four hours later. The dye is now distributed throughout the kidney, having diffused into the retained fluid.

considered, especially when physical examination revealed a large right-sided abdominal mass. Roentgen study of the abdomen disclosed a large, soft-tissue mass in the right renal area. A barium enema study showed the colon to be normal. An intravenous urogram showed normal morphology of the left urinary tract, but no clearance of diodrast on the right. A retrograde study on the right revealed a circular dye shadow with poorly defined margins in the kidney region (Fig. 1). A roentgenogram made twenty-four hours later showed that the dye previously injected had diffused throughout the soft-tissue mass, indicating a large hydronephrotic sac (Fig. 2).

*Urine:* Specific gravity (unconcentrated specimen), 1.019; albumin, faint trace; white blood cells, 25-30, per high power field.

*Blood:* Hemoglobin, 90 per cent; red cells, 4,000,000; white cells, 7,500.

Because of the patient's age and the rapid subsidence of symptoms, operation was not advised.

In this case the diagnosis was suggested by the earlier films, but the extent of the

<sup>1</sup> From the Department of Radiology, Hospital of the University of Pennsylvania, Philadelphia, Penna. Accepted for publication in August 1943.

lesion and its relation to the large soft-tissue mass were more exactly determined at twenty-four hours, when the dye previously injected had diffused throughout the dilated pelvis.

This procedure should be of value in those instances of a cavity containing fluid not amenable to drainage, in which ultimate but not immediate diffusion of the contrast medium can be attained. If the fluid-containing cavity is thoroughly

drained at the time of catheterization, complete refilling with an opaque medium will result at once.

To determine the necessity for delayed films the routine films should be studied immediately after processing. The time interval for the delayed examination will likewise be determined from the appearance of the conventional films.

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# Aortic Arch and Cardiac Mensuration<sup>1</sup>

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CARDIAC MEASUREMENT was the height of medical fashion and considered sacrosanct a quarter of a century ago. *The Heart and the Aorta; Studies in Clinical Radiology*, by H. Vaquez and E. Bordet is still a valuable reference book, copied by many subsequent authors. The more recent work of Hugo Roesler, Geza Nemet, and others, in cardiodynamics, with the brilliant anatomical fact finding by Robb and Steinberg's angiocardiology, places greater importance upon the individual cardiac segments and diminishes the value of cardiac mensuration. This still holds its place, however, as a permanent record for future estimation of progress.

Numerous workers have employed many methods of mensuration, each fitting in with the particular needs or whims of the individual investigator. It is not my desire to criticize or compare these. It is rather my purpose to set down the simplest procedure found feasible in my own experience with cardiac mensuration and to point out a practical variation from the standard technique in the measurement of the aortic arch.

A routine postero-anterior teleroentgenogram is made at 6 ft. (2 meters) distance with the patient standing in vertical position facing the film and in full inspiration, at 150 ma. and kv. variation corresponding to the postero-anterior thickness of the chest. After dark-room processing, the measurement procedure is as follows:

A preliminary survey is made of the chest to make certain that no conditions which would interfere with measurement exist, e.g., spinal curvature, mediastinal deviation, mediastinal or hilar disease, pleural effusion, etc. A mid-line is drawn by dropping a plumb line through the posterior spinous processes of the midcervical vertebrae. This can be checked against the equidistance of the sternal ends of the

clavicles. Next a horizontal line is drawn at the level of the cardiophrenic angle. Along this is measured the chest transverse diameter (Chest T.D.) from the inner rib borders on each side.

The greatest distance of the heart is then measured to the right of the mid-line (M.R.) and similarly to the left (M.L.). The sum of these two gives the transverse diameter, T.D., of the heart. The ratio of this to the chest transverse diameter is figured out in fraction form (2:1 ratio) or decimal percentage method (50 per cent).

The aortic arch mensuration is obtained by measuring the greatest distance from the mid-line to the left, which roughly approximates a 10:1 ratio to the chest transverse diameter. This variant in measurement we have found most satisfactory, because it eliminates the need to hunt for the right aortic arch margin so often hidden behind the sternum. The routine aortic arch transverse diameter is the sum of that part of the ascending portion of the arch which extends from the mid-line to the right border plus the part of the descending portion of the arch which extends from the mid-line to the left border.

W. W. Fray utilized the left anterior oblique position to measure the transverse diameter. Sosman emphasized the importance of the caliber of the aortic arch measured in the right anterior oblique. Roesler measured the aortic arch in the right anterior oblique after introduction of barium paste into the esophagus to delineate the adjacent right border of the arch. All these procedures necessitate either extra exposures to x-ray and a contrast medium, or both. This is obviated in the procedure here described, and the process is thereby simplified.

In a typical average small chest the x-ray examination would be reported as

<sup>1</sup> Accepted for publication in August 1943.

follows: Lungs clear. Heart normal in contour and size. Cardiac measurements as follows:

M.R. 4.2 cm.

M.L. 8.1 cm.

Heart T.D. 12.3 cm.

Chest T.D. 25.0 cm.

Cardiothoracic ratio  $12.3/25 = 49$  per cent

The aortic arch passes 2.5 cm. to left of the mid-line. The aortic thoracic ratio is 10 per cent (or 1 to 10).

#### SUMMARY

A simple routine of cardiac mensuration is set forth for future record and comparison purposes. This is not complete but is ample for routine work.

The aortic arch measurement is standardized by taking the distance from the mid-line to the left.

This procedure has been found practical in over twenty years' experience.

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# Training of X-Ray Technicians at the School for Medical Department Enlisted Technicians<sup>1</sup>

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THREE YEARS AGO, at the beginning of the army expansion program, it became apparent that a large number of trained technicians would be needed for service in the Medical Department of the United States Army. Although the proposed army of that time was relatively small compared with the present army, it was discovered shortly that the available technicians in the United States could not begin to fulfill the requirements of the armed forces. Furthermore, it was learned that the civilian schools and hospitals in which technicians could be trained were grossly inadequate to carry on such a tremendous task without seriously interfering with their normal essential functions. In view of these facts, the problem of training came to rest directly on the army.

At that time, the facilities within the army for training technicians were limited to a single school at the Army Medical Center, Washington, D. C. Obviously, this one school could not supply the thousands of technicians required for the various specialties, *i.e.*, medicine, surgery, radiology, laboratory technic, dentistry, and pharmacy. To provide a means of training additional enlisted medical personnel, plans were developed for the construction of additional training centers in different parts of the country. Of these new schools, the School for Medical Department Enlisted Technicians at the Fitzsimons General Hospital, Denver, Col., was one of the first to be opened.

The X-Ray Section of the Fitzsimons

School was first placed in operation on April 1, 1941. Since then, this school alone has supplied many hundreds of x-ray technicians to the armed forces.

Through necessity, the United States Army has thus had the opportunity not only to train hundreds of x-ray technicians but also to observe the results of such training. It is on the basis of such observation and experience during the past two and a half years that I wish to make the following remarks concerning the training of x-ray technicians. It is my sincere belief that we at Fitzsimons have developed a training program which has proved to be superior in many respects to the usual methods employed.

Simultaneously with the development of this school have come changes in the curriculum and in the methods of teaching. It is interesting to note that the changes which have been made have resulted largely from suggestions made by the students while enrolled here, through communications received from students who have graduated, and from radiologists in various army hospitals. Thus, the training program has been evolved from the experience of many persons with various responsibilities in the field of radiology.

The course for x-ray technicians at the present time extends over a period of three months, during which time the student receives 504 hours of technical instruction. This teaching occupies seven hours a day, six days a week. In addition, to the technical training, each student also receives an hour and a half a day of military training, which includes dismounted drill, calisthenics, parades, etc.

During the first month of the technical training an effort is made to familiarize the student thoroughly with the electro-

<sup>1</sup> Such schools are conducted by the Army and Navy General Hospital, Army School of Roentgenology, Wm. Beaumont General Hospital, Billings General Hospital, Brooke General Hospital, O'Reilly General Hospital, Fitzsimons General Hospital, Lawson General Hospital, Letterman General Hospital.

Paper read by title at the Twenty-ninth Annual Meeting of the Radiological Society of North America, Chicago, Ill., Dec. 1-2, 1943.

physical principles concerned with the production of x-rays, the nature and physical properties of the x-ray beam, and the manner in which x-rays are made use of in roentgenography. Because of the multiplicity of subjects covered in the first month, the scope of this training is best set forth in outline form as follows:

#### ELEMENTARY PHYSICS

- Atomic and electronic theory of matter
  - Construction of matter
  - Construction of molecules and atoms
- Magnetism
  - Types of magnets
  - Atomic and molecular theories of magnetism
  - Magnetic lines of force
  - Laws of magnetic force
  - Magnetic induction
- Electromagnetism
  - Relationship between magnetism and electricity
- Electricity
  - Electron theory of electricity
  - Electrical potential
  - Motions of electrons
  - Methods of causing electrons to flow
  - Conductors and insulators
  - Types of electricity
  - Types of electrical circuits
  - Electrical terminology
  - Ohm's law
  - Power law
  - Electrical measuring devices
  - Electrical controlling devices
  - Theory of electromagnetic induction, Lenz's law, induced e.m.f.
  - Motors
  - Generators
  - Transformers, conventional, auto-transformer

#### RADIOLOGIC PHYSICS

- Production of x-rays
  - Conditions necessary for the production of x-rays
  - Relation of kv.p. and ma. to the production of x-rays
- Rectification, mechanical, valve tube
- Wiring diagrams of x-ray circuits
  - Self-rectified
  - Mechanically rectified
  - Single-valve tube, half wave rectified
  - Four-valve tube, full wave rectified
  - Three-phase apparatus
  - Condenser discharge apparatus
- Calibration of x-ray machines
- Trouble shooting and service of x-ray apparatus
- X-ray tubes
  - Gas tubes
  - Hot cathode tubes
  - Variable-focus tubes

#### X-ray tubes—*cont.*

- Line-focus tubes
- Double-focus tubes
- Rotating anode tubes
- Shockproof and rayproof tubes

#### Radiant energy

- Theories of radiant energy
- Electromagnetic spectrum
- Nature of the x-ray beam
- Characteristics and physical properties of the x-ray beam
- Methods of utilizing the x-ray beam
- Methods of identifying the x-ray beam

#### RADIOGRAPHY

- Prime factors: ma., kv.p., distance, and time
- Film factors: detail, density, contrast, and distortion
- The x-ray film
- Processing of the x-ray film

The above subject material is presented to the students both in didactic lectures and in laboratory work, there being three hours a day of each type of instruction. The laboratory classes are so arranged that small groups of students either have demonstrated to them, or demonstrate to themselves, the material covered in the lectures. The remaining hour of each day is spent in small conference groups or in supervised study, during which time an instructor is present to aid the student with any problems which he may encounter.

The second month of instruction initiates the student into the technic of radiography. The 168 hours of instruction are divided in the following manner: 72 hours are allotted to radiography, 24 hours to film criticism, 24 hours to osteology, and 48 hours to laboratory work.

Approximately one hour of the three hours devoted to radiography is occupied in instructing the student in one or more of the standard radiographic positions of small parts of the body. This instruction includes both a lecture and a practical demonstration by the instructor in charge of the group. This instruction is supplemented by the use of lantern slides, which depict the various radiographic positions by means of models and demonstrate the radiograph obtained by such positioning. During the remaining two hours of this period the students occupy themselves by

taking radiographs of each other in the positions taught them that day.<sup>2</sup>

During the hour set aside for film criticism, the class is divided into small groups, and the films which the students have taken on the previous day are criticized by a medical officer. These films are analyzed from the standpoint of detail, density, contrast, distortion, and the position of the part on the film. If for any reason the film is found to be unsatisfactory or if the student has failed to identify the film properly, etc., he is called upon to suggest the modifications in his technic which would produce a satisfactory radiograph. The film is then rejected and the student must repeat the radiography of that particular part until a satisfactory result is obtained. This period of film criticism is also a valuable means of reviewing the radiographic anatomy discussed in the regular anatomy lectures.

The anatomy lectures of the second month occupy one hour daily and are confined to osteology. Each bony structure of the body is discussed from the standpoint of its gross anatomy, and special emphasis is placed on the radiographic significance of its various parts. A skeleton is used by the instructor during his lecture and is available to the student for reference at all other times. These lectures are also supplemented by lantern slides and radiographs of the various parts of the body, and a sincere effort is made to correlate the anatomy with the radiography. It is felt that such constant repetition of subject material, not only in this field, but in all subjects taught, en-

ables the student to grasp and to retain the important knowledge much more efficiently than an attempt to present one particular subject at a single sitting. Thus, at all times, the men are held responsible for any material covered up to that particular point in the course.

The two hours a day allotted to the laboratory are intended to acquaint the student with the various radiographic accessories and to familiarize him with the many aspects of radiography separate from the actual taking of radiographs. This includes instruction in the following:

- Darkroom procedure
  - Construction of darkroom
  - Chemistry of processing
  - Handling of x-ray film
- Administration
  - Care of supplies, records, reports, etc.
  - Organization of x-ray departments in military hospitals
- Intensifying screens
  - Purpose
  - Construction
  - Care
- Secondary radiation
  - Scattered
  - Characteristics
  - Corpuscular
  - Stray
- Cones, cylinders, diaphragms
  - Purpose
  - Construction
  - Use
- Potter-Bucky diaphragm and stationary grids
  - Purpose
  - Construction
  - Use
- Precautions in x-ray work
  - Dangers of electrical shock
  - Dangers of x-ray exposure
- Calibration of x-ray apparatus
  - Practical work
- United States Army field x-ray unit
  - Construction
  - Wiring diagrams
  - Operation
  - Assembling and disassembling unit
- X-ray tubes
  - Tube rating charts
- Prime factors of radiography
  - Detail
  - Density
  - Distortion
  - Contrast
  - Methods of compensating for changes in the prime factors

<sup>2</sup> When the practice of using students as subjects for radiography was first begun, the question arose as to the harmful effects which the students might experience from the many x-ray exposures. In order to avoid local damage to any skin areas, the students are carefully instructed in the skin tolerance dose, and an accurate record is kept of the amount of x-ray exposure to each part of the body. As a check against any harmful systemic effect, each student receives a complete blood count before he is exposed to any radiation and another similar blood count near the end of the course, or at any other time that it is deemed necessary. To date, hundreds of blood counts have been made on the students and instructors, and an analysis of these blood studies has revealed nothing to indicate that the students have received or are receiving a quantity of radiation which is deleterious to their health.

Models of the different radiographic accessories discussed are available for the students to examine, and many schematic models have been constructed by various members of the department to demonstrate or to emphasize certain points.

In addition to the work within the radiographic buildings, the men are started on field work and field problems such as they might encounter in actual combat. This includes instruction in assembling, operating, and disassembling the pieces of field equipment that have been specifically developed for this type of work, such as the field x-ray unit, the motor generator, the portable darkroom equipment, etc.

The work of the third month is in many respects similar to that of the second month except that it is more advanced. The 168 hours of instruction are divided in the following manner: 72 hours are allotted to radiography, 24 hours to film criticism, 36 hours to radiographic anatomy and physiology, and 36 hours to laboratory.

The three hours a day devoted to radiography constitute a continuation of the radiographic work of the second month. During this month the students are instructed in the radiography of the heavier parts of the body, as the skull, the spine, the chest, etc. The work of the second-month students is all performed on the field unit, which has an output of 30 ma., whereas the radiography of the third month is, for the most part, accomplished on stationary units with an output of 100 or 200 ma. In all, each student is required to have a minimum of 50 radiographs completed and passed during his second and third months of work. Instruction is given, however, in additional positions which the student may work on in his spare time.

The film criticisms of the third month are conducted precisely as those of the second month.

The anatomy lectures of the third month embrace a discussion, not only of the anatomy of the various systems of the

body, but of their physiology as well. These lectures are presented in such a way that the radiographic importance of the organ or organs being studied is emphasized. Thus, lectures on the biliary system are approached from the standpoint of a cholecystogram, those on the gastro-intestinal tract from the standpoint of a gastro-intestinal series and a barium enema, etc. These lectures, like those of the second month, are all supplemented by lantern slides, models of the organs being studied, etc.

The laboratory work of this month includes instruction in the following subjects: fluoroscopy, photofluorography, stereoscopy, laminagraphy, kymography, and foreign body localization. During this period, the use of the field equipment is enlarged upon and the student is given the opportunity to take a number of radiographs under field conditions. On frequent occasions this work is carried on in conjunction with the work of the medical and surgical sections of the school, and thus the student is provided with the opportunity of taking radiographs of simulated battle casualties—men whose extremities may be supported in splints or who may have various other types of dressings applied to the part to be examined. Frequent trips to the x-ray clinic of the Fitzsimons General Hospital familiarize the student with the operation of a large x-ray clinic and serve as a review for much of the material covered in the didactic lectures.

This last month includes a brief introduction to the field of x-ray therapy, although the scope of this instruction is limited, since most of the students will have no contact with x-ray therapy except perhaps that administered by the field unit. Lectures are also given on the ethics of x-ray technicians, and the students are constantly admonished as to the dangers of interpreting x-ray films when serving in the capacity of technicians.

Technical manual 8-240, "Roentgenographic Technicians," is used as the official, basic textbook. Other text and teaching

aids employed in carrying on the above instruction have, for the most part, been developed by persons working in the x-ray section. The student is, however, encouraged to indulge in collateral reading, and a library, containing many of the standard texts on physics and radiography, is available for this purpose at any time. All phases of the instruction are punctuated by frequent examinations, both written and practical, and those students who do not appear to be grasping the material as well as would be hoped are given additional tutoring.

At the present time, the greatest shortcoming of the entire course, as I see it, is the failure to be able to provide more practical hospital experience. I do not feel, however, that this constitutes such a serious objection, since, upon graduating, these men are assigned to hospital clinics in which there is generally a wealth of clinical experience. Furthermore, plans have already been developed extending the period of instruction to four months, in which case the students will be given the opportunity for actual work in the Fitzsimons Hospital x-ray clinic along with the regular technicians.

The reports which I have received from radiologists in army hospitals who have had the opportunity of observing the quality of the x-ray technicians trained under such a system as outlined have been most gratifying. I have been particularly impressed with the manner in which our graduates have been able to adapt themselves to the routine of the many varied radiographic departments to which they

have been assigned, and the way in which they have been able to adjust themselves to the idiosyncrasies and wishes of the radiologists in charge of these various departments. Not only have these men proved to be superior technicians, but in many instances they have been of value in servicing and maintaining the equipment in their clinics.

My experience in training x-ray technicians in accord with the method outlined has convinced me of the desirability of instituting some similar method of education for civilian student technicians. In this respect, I would like to suggest to the profession the possibility of endorsing or even establishing similar schools in civilian practice. It is my opinion that a well rounded course in the fundamentals of radiography should precede the hospital work of a student x-ray technician just as a course in medical school precedes the hospital work of a hospital intern. Such a practice would accomplish several very desirable results:

1. The training program for x-ray technicians would be more or less standardized throughout the country.
2. This training would be of benefit to physicians beginning their study in radiology.
3. The expensive errors occasionally committed by the neophyte technician would be less likely to occur.
4. The radiologist would be provided with a technician who would be of practical value from the very beginning of his or her hospital work.

# CASE REPORTS

## Congenital Absence of a Lung Diagnosed before Death<sup>1</sup>

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Congenital absence of a lung is looked upon as a rare occurrence. To substantiate this claim, a review of the literature reveals

the 34 cases recorded up to that time, with references to the original reports. The accompanying table brings their review to date. The feeling persists, however, that aplasia of the lung occurs much more frequently than is generally suspected and the possibility of such an occurrence should be considered in differential diagnosis of dis-

CASES OF CONGENITAL ABSENCE OF LUNG RECORDED FROM 1937 TO DATE  
(Cases up to 1937 (1-34) tabulated by Hurwitz and Stephens)

Author	Sex and Age	Absent Lung	Autopsy Findings
35. Hurwitz, S., and Stephens, H. B. (Am. J. M. Sc. 193: 81, 1937)	Female 7 weeks	Left	The rudiment of tissue that represented the left lung was attached to the end of a short narrow bronchus and weighed 2.5 gm. A vein from it entered the right vena azygos. Fetal lung tissue hypertrophied; one-lobed right lung
36. Elward, J. F. (Radiology 27: 667, 1936)	Male 43 years	Left	Right lung hypertrophied. A rudimentary left lung 3 × 1½ inches, fibrotic and adherent to the posterior chest wall. Bronchi incarcerated in a mass of adhesions. Marked diminution of left pulmonary artery
37. Van Loon, E. L., and Diamond, Sydney (Am. J. Dis. Child. 62: 584, 1941)	Female 3½ years	Right	Child alive at time of report
38. Madigan, D. G. (Tubercle 22: 144, 1941)	Female 23 years	Left	Right lung extending across mid-line with compensatory hypertrophy.
39-41. Castellanos, A., and Pereiras, R. (Bol Soc. cubana de pediat. 14: 268, 1942)	Female 10 years	Left	Child presumably alive at time of report
	Female 10 years	Right	Child presumably alive at time of report
	Infant 1 day	Left	Ovoid mass 2 × 3 cm. on left side.
42. Gartside, V. O. B., (Brit. J. Radiol. 16: 69, 1943)	Male 7 years	Left	Child alive at time of report
43. Olcott, C. T., and Dooley, S. M. (Am. J. Dis. Child. 6: 776, 1943)	Female 2 months	Right	Enlarged left lung. Trachea formed an almost direct line with the left bronchus. Barely recognizable pocket, not over 4 mm. in any dimension, at the normal site of branching of the right main bronchus. No tissue of any sort attached to the external aspect of the bronchus at this point

only 38 authenticated cases since Haberelein (2) reported the first example in 1787. The rarity of this condition is further borne out by the fact that only 3 of the recorded cases were diagnosed before death and in a number of instances aplasia of the lung was not suspected but was found at routine autopsy following death from trauma. Hurwitz and Stephens (5), reporting a case in 1937, tabulated details of

eases of the chest, particularly in what appears to be a persistent atelectasis.

One normally functioning lung is compatible with and sufficient for life and all ordinary needs, provided the lung remains healthy. The decrease in respiratory reserve is often offset by an increase in pulmonary tissue in the opposite lung, and instances have been reported where six lobes have been present. Compatibility of a single lung with life is further borne

<sup>1</sup> Accepted for publication in August 1943.



Fig. 1. Agenesis of right lung with wide shift of heart and mediastinum into the right thoracic cavity.

out by the fact that 11 of the cases reported were in patients twenty years of age or older. Herrero (4) reported a case in a man of sixty-five. Van Loon and Diamond's (7) patient was a child three and one-half years old who at the present time is still alive.

Schneider (6) recognizes three main types of pulmonary agenesis. The first type is a true aplasia with no trace of lung, bronchus, or vascular supply on the affected side. The second type is characterized by a small out-pouching from the trachea, with rudimentary bronchus. In the third type the bronchus is fully formed but ends in a fleshy mass of areolar tissue of varying amount.

The different types of pulmonary agenesis may be explained on an embryological basis. The lungs arise at the end of the fifth week as two bronchial buds which evaginate from the primordial trachea. These buds branch, forming the future bronchial tree. Failure of the lung to de-

velop may be due to an abnormality of the anlage of the lung or interference with its development or to regressive changes occurring at any time during the development of an anlage that had a normal beginning.

The left lung seems to be absent more frequently than the right lung. The incidence of the condition is about the same in either sex.

The following case is the second of congenital absence of a lung, seen in this hospital in the last six years (1). Both were diagnosed before death.

#### CASE HISTORY

J. M., male, aged six months, was admitted to Children's Mercy Hospital, Kansas City, Mo., Nov. 22, 1942, with a history of a cold, with cough and some cyanosis, of eight days' duration. The family history was irrelevant and the developmental history normal. The past history was negative except for a few transient spells of cyanosis.

The child appeared poorly nourished and somewhat cyanotic about the lips and fingers, breathing with some difficulty. Examination of the ears and nose was negative. The pharynx was injected. The chest was symmetrical, with some retraction at the suprasternal notch; coarse râles were heard over the entire chest, and there was dullness to percussion over the right upper lobe with suppressed breathing over the same area. The heart was regular, with no murmurs. There were no abdominal masses. There were no significant findings referable to the skin or genitals. The temperature was 102.4° by rectum; respirations 40.

*Admission Diagnosis:* Acute bronchitis, pharyngitis, and atelectasis of the right upper lobe.

Sulfathiazole was administered and the child was placed in a croup tent.

A roentgenogram of the chest showed a dense homogeneous opacity over the entire right lung field, with a wide displacement of the mediastinal structures and the cardiac shadow toward the right, the latter lying completely on the right side of the vertebral column. There was complete loss of shadow of the right diaphragm, retraction of the right lung field, a definite narrowing of the interspaces. There was an over-aeration of the entire left lung, with the lung extending across the right side of the chest.

A bronchoscopic examination was performed on Nov. 24. A 4-mm. Jackson bronchoscope was passed with little difficulty. The epiglottis was curved and normal. The vocal cords were slightly injected. The trachea deviated to the right and appeared continuous with the left main bronchus. No opening of the right main stem bronchus could be found.

The mucosa of trachea and left main stem bronchus was injected, and a small amount of thick tenacious secretion was removed. It was believed that a congenital condition was present rather than an acquired one.

The child's condition remained unchanged and a second chest plate was ordered.

Re-examination after an interval of twenty-four hours revealed no change in the appearance of the thoracic structures. The heart and mediastinum were well over in the right thoracic cavity and there was hyperventilation of the left lung. Obviously no air was entering any portion of the right lung. The findings were considered not inconsistent with a true agenesis of the right lung.

The child's condition became much worse and death occurred Nov. 25.

Autopsy was performed by Dr. Nathaniel Soderberg. The usual Y-shaped incision was made from mid-manubrium to the symphysis pubis and the ends curved laterally beneath the clavicles. Examination of the chest showed an absence or autolysis of the lung on the right side. Further examination showed no lung at all on that side. There was a shifting of the mediastinum toward the right. The left lung was present and showed a patchy confluent bronchial pneumonia-like lesion. There appeared to be no bronchus whatever on the right side. The heart was somewhat dilated. The epicardium, endocardium, myocardium, valve rings, and coronary arteries were grossly negative. The rest of the autopsy findings were unimportant.

#### DISCUSSION

The increased use of routine chest plates in the armed services, among war workers, and particularly among school children, will undoubtedly bring to light more cases of congenital absence of a lung. Agenesis of the lung is a definite clinical entity. Its early recognition will give the patient a much better chance for life. Diagnosis may be made on the basis of x-ray examination, lipiodol injection, and bronchoscopy.

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#### REFERENCES

1. GILKEY, H. M.: *J. Missouri M. A.* 25: 296, 1928.
2. HABERLEIN: *Akad. z. Wien* 1: 271, 1787.
3. HEERUP, L.: *Hospitalstid.* 70: 1165, 1927.
4. HERRERO: *Corresp. Med.* 9: 372, 1874.
5. HURWITZ, S., AND STEPHENS, H. B.: *Am. J. M. Sc.* 193: 81-87, January 1937.
6. SCHNEIDER, P.: in SCHWALBE, E.: *Die Morphologie der Missbildungen des Menschen und der Tiere.* Jena, Gustav Fischer, 1913, Vol. 3, Pt. 2, pp. 817-821.
7. VAN LOON, E. L., AND DIAMOND, S.: *Am. J. Dis. Child.* 62: 584, 1941.

## Hereditary Cleidocranial Dysostosis<sup>1</sup>

MAJOR D. D. SALMON, M.C., A.U.S.

Cleidocranial dysostosis (cleidocranial dysosteogenesis, congenital cleidal dysostosis) is a relatively rare congenital defect of the skeleton characterized clinically by complete or incomplete aplasia of one or both clavicles, delayed ossification of the fontanelles with defective closure of the sutures, and hereditary transmission.

Among the clinical findings by which this condition may be recognized, abnormal mobility of the shoulders is probably the most striking. In severe cases, the shoulders may be made to meet in front. Another finding readily observed is the presence of a median furrow in the frontal bone, with prominent bosses. A history of either of these defects in other members of the family is suggestive of the diagnosis. The roentgenogram offers the final diagnostic criterion.

The head is large and of peculiar contour, with evidence of delayed and incomplete ossification of the bones. As a rule, the frontal and parietal eminences are particularly prominent, with considerable disproportion between the bones of the calvarium and those of the face. The development of the teeth is usually delayed, and tardy eruption of the deciduous set is observed. Late loss of the deciduous teeth with incomplete and deficient replacement by the permanent teeth is rather commonly reported. Faulty implantation, defective enamel coating, deficiency of development of the root portions, impactions, and supernumerary tooth buds, suggesting that the dystrophy is preosseous and pre dental, have been described by several writers.

The disease is usually diagnosed during roentgenographic examination for some other reason, such as trauma or suspected functional abnormality of the shoulder joints. Several cases in which defective implantation of the teeth first drew attention to the condition have been recorded. Patients are about equally divided between the two sexes.

<sup>1</sup> Accepted for publication in August 1943.





Fig. 1. Photograph of patient showing abnormal mobility of shoulders.

The exact etiology of cleidocranial dys trophy is unknown. That it is preosseous and preterminal in origin, as suggested above, has been emphasized by Anspach and Huepel. Among the etiological factors which have been considered are the occurrence of amniotic bands with hypertension of the amniotic fluid, abnormalities of the germ plasm, injury to the embryo, arrested development, and absence of certain chemical constituents necessary for the calcification of the membranous bones. Of these, the idea of germ plasm abnormalities appears to be the most tenable.

#### ROENTGENOGRAPHIC FINDINGS

The physical findings previously enumerated are easily confirmed by x-ray, while additional bone defects may be detected only by roentgenographic examination. The nasal sinuses may be incompletely developed or absent. The orbital rims may be incomplete, and there may be an associated hypertelorism. The squamous portion of the temporal bone is rudimentary, and the zygomatic arch is incomplete. Lack of pneumatization of

the mastoids may be observed, and persistent mastoid fontanelles may be seen. Prognathism is frequently more real than relative, with associated brachycephaly. Absence or underdevelopment of the nasal and lacrimal bones, with a depressed or flat nasal bridge and a narrow, highly arched palate, is often present.

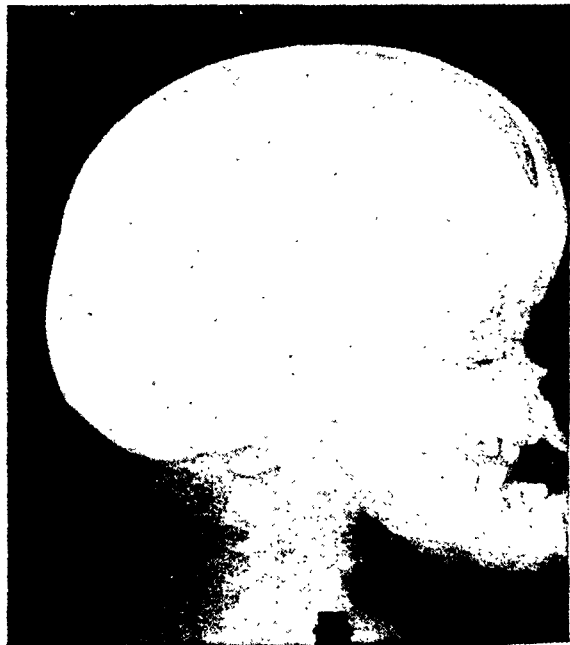


Fig. 2. Lateral view of skull showing slight disproportion between the calvarium and face. The maxilla is underdeveloped and the mandible is slightly suggestive of prognathism. There are marked dental irregularities. The osseous defect in the frontal bone is clearly demonstrated. The squamous and mastoid processes of the temporal bone appear rudimentary and there is no evidence of pneumatization. The sella turcica appears normal. The lambdoid suture is unfused and numerous wormian bones are seen in it. The atlas appears to be fused to the axis.

The incomplete ossification of membranous bones is observed again in the formation of wormian bones adjacent to the lambdoid suture. Spina bifida is seen, sometimes with an associated fusion of the vertebral bodies. The pelvis may be deficient, with absence of ossification at the symphysis pubis, blunting of the heads and shortening of the necks of the femurs. Malformation of the joints and phalanges of the fingers has been recorded.

#### CASE REPORT

L. O. P., a soldier of French-Irish descent, 21 years old, had suffered all his life from severe

headaches after exposure to sunlight and since being in the Army had experienced extreme fatigue and a feeling of weight in the neck and shoulders after calisthenics. When encouraged to describe his complaints, he demonstrated prominent frontal bosses and a "soft spot" in the mid-line of the frontal and parietal bones. Also, he displayed ability to approximate his shoulders anteriorly, explaining that he had no collar bone.

The medical history revealed a normal birth and

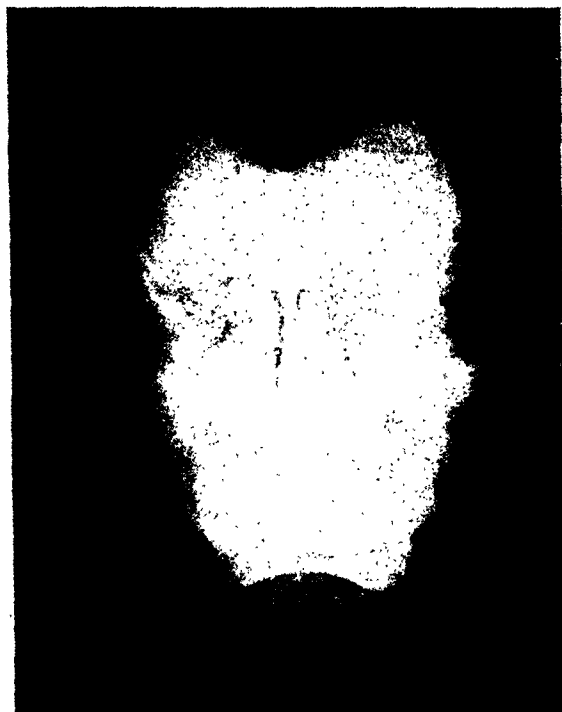


Fig. 3. Postero-anterior nose-chin view showing mid-line defect in the frontal bone. The maxilla is underdeveloped, with vaguely defined rudimentary maxillary sinuses. Note failure of development of frontal sinuses and poorly developed zygomatic arches.

normal childhood, except for late eruption of the deciduous teeth, which were not otherwise extraordinary. When these were lost, late in adolescence, some were never replaced by permanent teeth. Following a bicycle accident in 1940, several roentgenograms had been made at the Shreveport Charity Hospital, Shreveport, La., and there the patient was told about his condition. His father, living and well at the age of 52, was said to have a median furrow in the frontal bone and prominent bosses but no "soft spot" in his head. He could easily approximate his shoulders anteriorly. The patient's mother died when he was rather young, but he had been told that she had none of the bony defects described by him as occurring in other members of his family. One sister, 14 years of age, was said to have very sloping shoulders, which she could bring together in front. She did not have a furrow in the frontal bone, prominent frontal bosses, or a

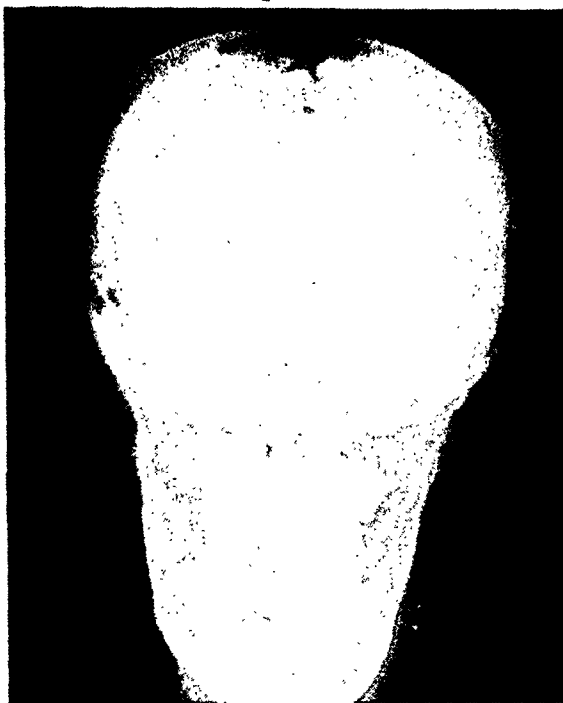


Fig. 4. Postero-anterior nose-forehead view showing bony defect of unossified cartilage corresponding to median frontal furrow, unfused lambdoidal sutures, and absence of frontal sinuses. Teeth are in position of occlusion.

"soft spot" like her brother. No roentgen studies of the father and sister had been made.

The patient was of short, stocky stature, with excellent muscular development, and was intelligent and co-operative. His head appeared large, the calvarium seeming out of proportion to the face. A noticeable median depression extended from the hairline to the root of the nose. The frontal bosses were prominent, and there was a suggestion of prognathism. Only eleven teeth were present, six of which were situated anteriorly. All the teeth were carious in varying degrees. The shoulders were sloping and abnormally mobile, so that the patient could easily approximate them anteriorly (Fig. 1).

The laboratory findings were not significant. The blood and urine were normal. The Kahn reaction was negative.

Roentgenographically a slight disproportion between the bones of the calvarium and face was demonstrable. The latter appeared underdeveloped, as evidenced by small nasal and lacrimal bones. A lateral view of the skull (Fig. 2) showed a small, underdeveloped maxilla, with supernumerary teeth, misplaced teeth, conically formed teeth, and numerous impactions. The maxillary sinuses were small and vaguely defined, suggesting underdevelopment. The mandible appeared normal, with a slight suggestion of prognathism. The same dental irregularities were seen as in the maxilla. There

logical strength of the bone. The onset of symptoms is usually gradual but may be abrupt. In the metatarsal area there is gradually increasing discomfort when the body weight is placed on the foot, which may increase to the point of complete disability. Swelling and edema, especially on the dorsum of the foot, are frequently associated. Treatment is by immobilization and relief of weight-bearing, with gradual return to full activity.

Fatigue fractures do not appear to have been reported in the tibia until 1938, but since that time a number of such cases have been published. Krause (3) reported four examples in soldiers. The most common site appears to be at the junction of the middle and upper thirds of the tibia. The fracture is usually incomplete, but may progress to a complete fracture following a relatively slight injury. There is no soft tissue swelling and no osteoporosis. Most of the callus is seen posteriorly and medially, indicating that bone proliferation tends to follow the line of greatest stress.

Hartley (1) calls attention to the fact that lateral roentgenograms of the tibia indicate that the maximum transmission of weight is posterior to the long axis of the tibia, as the bony architecture shows stress lines to be accentuated in the triangular area behind the mid-point of the internal condyle. These lines meet at the cortex, about 3 inches below the condyle, very near the point of origin of these fractures. This is taken as additional evidence that the fractures are due to bony fatigue or exhaustion.

A case of "fatigue" fracture of the femur has been reported by Peterson (4). This was in a 17-year-old boy, who experienced sudden pain during exercise after a lengthy period of inactivity. A roentgenogram disclosed a slight crack in the femoral cortex. Later a diagnosis of bone tumor was made, but progressive callus formation finally clinched the diagnosis of fracture.

Jones (5), in a recent report, describes "march" fractures of the inferior pubic ramus occurring in three soldiers. They

complained of gradually developing pain along the adductor aspect of the thigh following exercise, with no history of trauma. All made satisfactory recoveries following simple bed rest.

A case of "exhaustion" fracture of the spine is reported by Hartley (1), who believes that excessive overloading was the contributing factor. It occurred in a boy 17 years of age who was carrying sacks of coal weighing 100 pounds on his back. The pain came on suddenly and was acute in nature. Roentgenograms showed compression of the 5th dorsal vertebra. This narrowing of the vertebra increased during a one-week interval when there was no attempt at extension of the spine.

The frequent reports of fatigue fractures during the past five years emphasize the role which abnormal stresses play in their etiology. Most of the cases have occurred in recruits in the military service, who were subjected to unaccustomed physical tasks. It should be noted that nearly all of the patients are young persons. Differentiation of these fractures from sarcoma, which has been seriously considered in several of the reported cases, is especially important. Callus formation is a prominent feature and is often out of all proportion to the extent of the fracture. Radiologists must be on their guard to recognize the condition, especially in view of the compensation angle. Finally, a standardized name should be adopted. "Fatigue" fracture, as advocated by Hartley, would seem to be acceptable from both an etiologic and descriptive point of view.

#### REFERENCES

1. HARTLEY, J. BLAIR: Stress or Fatigue Fractures of Bone. *Brit. J. Radiol.* 16: 255-262, September 1943.
2. KRAUSE, GEORGE R.: March Fracture. *Radiology* 38: 473-476, April 1942.
3. KRAUSE, GEORGE R., AND THOMPSON, JOHN R., JR.: March Fracture of the Tibia. *Radiology* 41: 580-585, December 1943.
4. PETERSON, L. T.: March Fracture of the Femur. Report of a Case. *J. Bone & Joint Surg.* 24: 185-188, January 1942.
5. JONES, DEAN B.: March Fracture of the Inferior Pubic Ramus. Report of Three Cases. *Radiology* 41: 580-588, December 1943.
6. HARTLEY, J. BLAIR: Exhaustion Fracture of the Spine. *Brit. J. Radiol.* 16: 348, November 1943.

Joint Meeting  
The Radiological Society of North America  
and  
The American Roentgen Ray Society

The Palmer House, Chicago, Ill.

September 24 to 29, 1944

In the March issue of *Radiology* there appeared a preliminary announcement of a joint meeting of the American Roentgen Ray Society and the Radiological Society of North America to be held in Chicago, Sept. 24 to 29, 1944.

The expressed opinion of those who have been contacted indicates that this meeting will be extremely welcome to all radiologists in the United States and Canada. It will afford a much-needed opportunity for the exchange of views and ideas, as well as constituting a valuable source of information and instruction.

Joint committees have been appointed and it will be their responsibility to arrange for the Commercial and Scientific Exhibits, Refresher Courses, and the Scientific Program. May we suggest that members of both societies make an immediate survey of their material and put forth a consistent effort to contribute either to the program or exhibits.

The Coordinating Committee, consisting of Dr. Lyell C. Kinney (1831 Fourth Ave., San Diego 1, Calif.), Dr. Edward L. Jenkinson (St. Luke's Hospital, Chicago, Ill.), and Dr. Eldwin R. Witwer (Harper Hospital, Detroit 1, Mich.), will be delighted to be of any possible assistance in arrangements. Titles and abstracts of papers should be submitted to Doctor Kinney or Doctor Witwer before July 1, 1944.

Dr. Lawrence Reynolds (10 Peterboro, Detroit 1, Mich.) is Chairman of the Commercial Exhibits Committee. Prospective exhibitors should communicate with Doctor Reynolds for space at an early date.

The Scientific Exhibits Committee, of which Dr. Clarence Hufford (421 Michigan St., Toledo, Ohio) is Chairman, will be in a position to send out application blanks for space in the near future. Those who are planning to present exhibits will find it advantageous to prepare films, charts, graphs, and specimens at the earliest possible time.

Dr. Warren Furey (6844 Oglesby Avenue, S. Chicago Station, Ill.) heads the committee in charge of the Refresher Courses, which will start Sunday, Sept. 24. The combined talent available in the two societies makes it certain that these will be of outstanding character. Doctor Furey should be contacted immediately, so that he may make the most advantageous arrangement of available material in arranging these courses.

We are certain that members of both the Radiological Society of North America and the American Roentgen Ray Society appreciate the importance of this meeting. Their officers and committees solicit their support in making it one of the outstanding radiological meetings of all time.

ELDWIN R. WITWER, *President*  
*Radiological Society of North America*

## ANNOUNCEMENTS AND BOOK REVIEWS

### INTER-AMERICAN COLLEGE OF RADIOLOGY

At the First Inter-American Radiological Congress held in Buenos Aires in October, action was taken authorizing the formation of an Inter-American College of Radiology, with headquarters in Buenos Aires, and the following committee was appointed to organize the body: Dr. Merlo Gómez, Dr. José Saralegui, Dr. Pedro Fariñas (Cuba), Dr. Mata Martínez (Ecuador), and Prof. Carlos Butler (Montevideo).

The next Inter-American Congress was set for 1945, inasmuch as that year marks the fiftieth anniversary of Roentgen's discovery, and Habana, Cuba, was chosen as the probable meeting place.

### CANCER TEACHING DAY

Schenectady, N. Y.

A Cancer Teaching Day will be observed April 20, 1944, at Schenectady, N. Y., with a program, presented under the auspices of the Medical Society of the County of Schenectady, the Medical Society of the State of New York, and the New York State Department of Health, Division of Cancer Control.

The speakers at the afternoon meeting, to be held at 3 o'clock at the Ellis Hospital, will be Wm. H. Woglom, M.D., Associate Professor of Cancer Research, Columbia University, and Arthur Purdy Stout, M.D., Associate Professor of Surgery, Columbia University. Dinner will be served at 6:30 P.M. at the Mohawk Golf Club, followed by the evening session. The speakers at this meeting will be Fordyce B. St. John, M.D., Professor of Clinical Surgery, Columbia University, and Hayes E. Martin, M.D. Asst. Professor of Clinical Surgery, Cornell University Medical College.

Dr. Ellis Kellert, Ellis Hospital Laboratory, Schenectady 8, N. Y. is chairman of the committee on arrangements.

### In Memoriam

CHARLES FREDERICK BAKER, M.D.

1876-1944

Dr. Charles F. Baker, who died on March 6, 1944, was born in Newark, N. J. Following his graduation from the College of Physicians and Surgeons of Columbia University (1902), he served his internship at the Newark City Hospital and continued the practice of his profession in the city of his birth. He maintained his own x-ray laboratory for many years and played an important role in the advancement of his specialty in New Jersey. He was director of the Department of Roentgenology at the

Babies Hospital-Coit Memorial, St. Barnabas Hospital, the Eye and Ear Infirmary, and the Presbyterian Hospital, all of Newark, and of the Orange Memorial Hospital, Orange, N. J.; and consulting roentgenologist at the East Orange General Hospital, East Orange, N. J.

Doctor Baker was a diplomate of the American Board of Radiology, a member of the Radiological Society of North America, and a member and former president of the Radiological Society of New Jersey.

KURT FRIEDRICH BEHNE, M.D.

1885-1944

Dr. Kurt F. Behne, of Los Angeles, a member of the Radiological Society since 1928, died on Jan. 15, 1944. Doctor Behne came to America from Germany, where he received his medical training. He was licensed to practise medicine in California in 1924.

ARCHIE DUNCAN IRVINE, M.D.

1903-1944

Word has been received of the death on Feb. 12, 1944, of Dr. A. D. Irvine of Edmonton, Alberta. Doctor Irvine was graduated in medicine from the University of Toronto in 1931. He was radiologist to the Edmonton General and Misericordia Hospitals in Edmonton and Honorary Demonstrator in Radiology at Alberta University. He was a diplomate of the American Board of Radiology and a member of the American College of Radiology, the Radiological Society of North America, and the Canadian Association of Radiologists.

HENRY P. ENGELN

1870-1944

The following resolution of the Cleveland Radiological Society was ordered at the February meeting, 1944.

"WHEREAS: Death has removed from our Society Mr. Henry P. Engeln, the following brief outline is submitted for incorporation in the records.

"He was born in Paris, France, in 1870 and died at St. Luke's Hospital, Cleveland, Ohio, on February 7, 1944. He came to the United States with his parents, when about 15 years of age; they settled in Chicago, Ill. There he grew into manhood and was in business with his brother, until he came to Cleveland, about the year 1900. Here he engaged in the manufacturing of revolving plate static machines. This first brought him in touch with the x-ray field. He cooperated with Dr. George Iddings, in establishing the first x-ray laboratory in

Cleveland, which was located in the Caxton Building on Huron Road. He continued in this field the rest of his business life. He was associated with several leading x-ray organizations and for many years headed his own, the H. P. Engeln Co. He was always interested in everything pertaining to this branch of medicine. He regularly attended both national and international meetings, was known to hundreds of radiologists and probably knew personally more pioneer radiologists than any other member. Even after retiring from active work a few years ago, he visited and enjoyed being with his old x-ray friends.

"As a Society we wish to extend to his family our sympathy at his passing and assure them we hold fondly the memory of this friendly friend.

"Therefore: Be it ordered that a copy of this Resolution be sent to the family, the *American Journal of Roentgenology and Radiology*."

## Books Received

Books received are acknowledged under this heading, and such notice may be regarded as recognition of the courtesy of the sender. Reviews will be published in the interest of our readers and as space permits.

**THE RADIOLOGY OF BONES AND JOINTS.** By JAMES F. BRAILSFORD, M.D., Ph.D., F.R.C.P., F.I.C.S., Hunterian Professor, Royal College of Surgeons, England, 1934-35, 1943-44; First President of the British Association of Radiologists; Radiological Demonstrator in Living Anatomy, the University of Birmingham; Honorary Radiologist to the Queen Elizabeth Hospital, Birmingham; Honorary Radiologist to the Royal Cripples' Hospital, and the Warwickshire Orthopaedic Hospital; Radiologist to St. Chad's Hospital, the City of Birmingham Infant Welfare Centres and the Military Hospital, Hollymoor, Birmingham; Consulting Radiologist to the City of Birmingham Hospitals, the Robert Jones and Agnes Hunt Orthopaedic Hospital, the Birmingham Accident Hospital and Rehabilitation Centre, the Birmingham Mental Hospital; Late Radiologist, the Birmingham War Hospitals and Ministry of Pensions Hospitals. Third Edition. A volume of 440 pages with 404 illustrations. Published by J. & A. Churchill, Ltd., 104 Gloucester Place, Portman Square, London, 1944. Price 45 shillings.

**PHYSICAL FOUNDATIONS OF RADIOLOGY.** By OTTO GLASSER, Ph.D., Professor of Biophysics and Head of Department of Biophysics, Cleveland Clinic Foundation, Cleveland, Ohio; EDITH H. QUIMBY, Sc.D., Associate Professor of Radiology (Physics), College of Physicians and Surgeons, Columbia University, New York; LAURISTON S. TAYLOR, Ph.D., Chief of X-Ray Section, National Bureau of Standards, Washington, D. C.; and J. L. WEATHERWAX, M.A., Philadelphia General Hospital and Graduate School of Medicine, University of Pennsylvania, Philadelphia. A volume of 426 pages, with 95 illustrations and numerous depth-dose tables. Published by Paul B. Hoeber, Inc., New York. Price \$5.00.

**MEDICAL PHYSICS.** Editor-in-Chief, OTTO GLASSER, Ph.D., Head of Department of Biophysics, Cleveland Clinic Foundation; Professor of Biophysics, Frank E. Bunts Educational Institute; Consulting Biophysicist, University Hospitals of Cleveland, Cleveland, Ohio. Associate Editors: *Anatomy*: Normand L. Hoerr, M.D., Ph.D.; *Bacteriology*: Otto Rahn, Ph.D.; *Biometrics*: Charles P. Winsor, Ph.D.; *Biophysics*: Otto Glasser, Ph.D.; *Dermatology*: George W. Binkley, M.D.; *Hematology*: Eric Ponder, M.D., D.Sc.; *Medicine*: Russell L. Haden, M.D.; *Neurology*: W. James Gardner, M.D.; *Nuclear Physics*: Robley D. Evans, Ph.D.; *Ophthalmology*: Albert D. Ruedemann, M.D.; *Optics*: W. B. Rayton, D.Sc.; *Orthopedics*: James A. Dickson, M.D.; *Otolaryngology*: Paul M. Moore, Jr., M.D.; *Pathology*: Harry Goldblatt, M.D., C.M.; *Pediatrics*: Norman C. Wetzel, M.D.; *Photography*: Leo C. Massopust; *Physical Chemistry*: Francis M. Whitacre, Ph.D.; *Physical Therapy*: Walter J. Zeiter, M.D.; *Physics (Instruments and Methods)*: John G. Albright, Ph.D.; *Physiology*: Harold D. Green, M.D.; *Radiology*: Harry Hauser, M.D.; *Surgery*: Frederick R. Mautz, M.D.; *Urology*: Charles C. Higgins, M.D. A volume of 1,744 pages, with numerous illustrations. Published by The Year Book Publishers, Inc., Chicago. Price \$18.00.

**METABOLISM MANUAL.** By JESSIE K. LEX, R.T., M.T. (ASCP), President Illinois Society Clinical Laboratory Technicians 1942-43, Chief Medical Technologist, Chief X-Ray Technician, the Diagnostic Clinic of George W. Parker, M.D., and George Mason Parker, M.D., Peoria, Illinois. A volume of 56 pages, with numerous charts. Published by The Waverly Press, Baltimore. Price \$1.75.

# RADIOLOGICAL SOCIETIES OF NORTH AMERICA

*Editor's Note.*—Will secretaries of societies please cooperate by sending information to Howard P. Doub, M.D., Editor, Henry Ford Hospital, Detroit 2, Mich.

## UNITED STATES

*Radiological Society of North America.*—Secretary, D. S. Childs, M.D., 607 Medical Arts Building, Syracuse, N. Y.

*American Roentgen Ray Society.*—Secretary, Harold Dabney Kerr, M.D., Iowa City, Iowa.

*American College of Radiology.*—Secretary, Mac F. Cahal, 540 N. Michigan Ave., Chicago, Ill.

*Section on Radiology, American Medical Association.*—Secretary, J. T. Murphy, M.D., 421 Michigan St., Toledo, Ohio.

## ARKANSAS

*Arkansas Radiological Society.*—Secretary, J. S. Wilson, M.D., Monticello. Meets every three months and annually at meeting of State Medical Society.

## CALIFORNIA

*California Medical Association, Section on Radiology.*—Secretary, Earl R. Miller, M.D., University of California Hospital, San Francisco, Calif.

*Los Angeles County Medical Association, Radiological Section.*—Secretary, Roy W. Johnson, M.D., 1407 South Hope St., Los Angeles. Meets second Wednesday of each month at County Society Building.

*Pacific Roentgen Society.*—Secretary, L. Henry Garland, M.D., 450 Sutter St., San Francisco. Meets annually during meeting of California Medical Association.

*San Diego Roentgen Society.*—Secretary, Henry L. Jaffe, M.D., Naval Hospital, Balboa Park, Calif. Meets first Wednesday of each month.

*San Francisco Radiological Society.*—Secretary, Martha Mottram, M.D., Suite 1789, 450 Sutter St., San Francisco. Meets monthly on third Thursday at 7:45 P.M., in Toland Hall, University of California Hospital, from January to June; at Lane Hall, Stanford University Hospital, July to December.

## COLORADO

*Denver Radiological Club.*—Secretary, Edward J. Meister, M.D., 366 Metropolitan Bldg. Meetings third Friday of each month at the Denver Athletic Club.

## CONNECTICUT

*Connecticut State Medical Society, Section on Radiology.*—Secretary, Max Climan, M.D., 242 Trumbull St., Hartford. Meetings bimonthly, on second Thursday.

## FLORIDA

*Florida Radiological Society.*—Acting Secretary, Walter A. Weed, M.D., 204 Exchange Building, Orlando.

## GEORGIA

*Georgia Radiological Society.*—Secretary-Treasurer, James J. Clark, M.D., 478 Peachtree St., N. E., Atlanta. Meetings twice annually, in November and at the annual meeting of State Medical Association.

## ILLINOIS

*Chicago Roentgen Society.*—Secretary, Warren W. Furey, M.D., 6844 S. Oglesby Ave. Meets at the Palmer House, second Thursday of October, November, January, February, March, and April.

*Illinois Radiological Society.*—Secretary-Treasurer, William DeHollander, M.D., St. Johns' Hospital, Springfield. Meetings quarterly by announcement.

*Illinois State Medical Society, Section on Radiology.*—Secretary, Fay H. Squire, M.D., 1753 W. Congress St., Chicago.

## INDIANA

*The Indiana Roentgen Society.*—Secretary-Treasurer, Harold C. Ochsner, M.D., Methodist Hospital, Indianapolis. Annual meeting in May.

## IOWA

*The Iowa X-ray Club.*—Holds luncheon and business meeting during annual session of Iowa State Medical Society.

## KENTUCKY

*Kentucky Radiological Society.*—Secretary-Treasurer, Sydney E. Johnson, M.D., Louisville City Hospital, Louisville. Meeting annually in Louisville, third Saturday afternoon in April.

## LOUISIANA

*Louisiana Radiological Society.*—Secretary-Treasurer, Johnson R. Anderson, M.D., North Louisiana Sanitarium, Shreveport. Meets annually at same time as State Medical Society.

*Shreveport Radiological Club.*—Secretary-Treasurer, R. W. Cooper, 940 Margaret Place. Meetings monthly on the second Wednesday, at the offices of the various members.

## MARYLAND

*Baltimore City Medical Society, Radiological Section.*—Secretary, Walter L. Kilby, M.D., 101 W. Read St. Meetings are held the third Tuesday of each month.

## MICHIGAN

*Detroit X-ray and Radium Society.*—Secretary-Treasurer, E. R. Witwer, M.D., Harper Hospital, Detroit. Meetings first Thursday of each month from October to May, inclusive, at Wayne County Medical Society club rooms, 4421 Woodward Ave., Detroit.

*Michigan Association of Roentgenologists.*—Secretary-Treasurer, E. M. Shebesta, M.D., 1429 David Whitney Bldg., Detroit. Meetings quarterly by announcement.

## MINNESOTA

*Minnesota Radiological Society.*—Secretary, John P. Medelman, M.D., 572 Lowry Medical Arts Bldg., St. Paul. Meetings quarterly.

## MISSOURI

*Radiological Society of Greater Kansas City.*—Secretary, Arthur B. Smith, M.D., 306 E. 12th St., Kansas City, Mo. Meetings last Thursday of each month.

*The St. Louis Society of Radiologists.*—Secretary, E. W. Spinzig, M.D., 2646 Potomac St. Meets on fourth Wednesday of each month except June, July, August, and September, at a place designated by the president.

## NEBRASKA

*Nebraska Radiological Society.*—Secretary, F. L. Simonds, M.D., 1216 Medical Arts Bldg., Omaha. Meetings third Wednesday of each month at 6 P.M. in either Omaha or Lincoln.

## NEW ENGLAND

*New England Roentgen Ray Society* (Maine, New Hampshire, Vermont, Massachusetts, and Rhode Island).—Secretary, Hugh F. Hare, M.D., Lahey Clinic, Boston, Mass. Meets monthly on third Friday at Boston Medical Library.

## NEW JERSEY

*Radiological Society of New Jersey.*—Secretary, H. J. Perlberg, M.D., Trust Co. of New Jersey Bldg., Jersey City. Meetings at Atlantic City at time of State Medical Society and midwinter in Newark as called by president.

## NEW YORK

*Associated Radiologists of New York, Inc.*—Secretary, William J. Francis, M.D., 210 Fifth Ave., New York City. Regular meetings the first Monday evening of the month in March, May, October, and December.

*Brooklyn Roentgen Ray Society.*—Secretary-Treasurer, Leo Harrington, M.D., 880 Ocean Ave. Meetings held the fourth Tuesday of every month, October to April.

*Buffalo Radiological Society.*—Secretary-Treasurer, Joseph S. Gianfranceschi, M.D., 610 Niagara St. Meetings second Monday evening each month, October to May, inclusive.

*Central New York Roentgen Ray Society.*—Secretary-Treasurer, Carlton F. Potter, M.D., 425 Waverly Ave., Syracuse. Meetings are held in January, May, and October, as called by Executive Committee.

*Long Island Radiological Society.*—Secretary, Marcus Wiener, M.D., 1430 48th St., Brooklyn. Meetings fourth Thursday evening each month at Kings County Medical Bldg.

*New York Roentgen Society.*—Secretary, Haig H. Kasabach, Presbyterian Hospital, New York, N. Y.

*Rochester Roentgen-ray Society.*—Secretary, S. C. Davidson, M.D., 277 Alexander St. Meetings at convenience of committee.

## NORTH CAROLINA

*Radiological Society of North Carolina.*—Secretary-Treasurer, Major I. Fleming, M.D., 404 Falls Road, Rocky Mount. Meeting with State meeting in May, and meeting in October.

## NORTH DAKOTA

*North Dakota Radiological Society.*—Secretary, L. A. Nash, M.D., St. John's Hospital, Fargo. Meetings by announcement.

## OHIO

*Ohio Radiological Society.*—Secretary, J. E. McCarthy, M.D., 707 Race St., Cincinnati. The next meeting will be held at the time and place of the annual meeting of the Ohio State Medical Association.

*Cleveland Radiological Society.*—Secretary-Treasurer, Don D. Brannan, M.D., 11311 Shaker Blvd., Cleveland 4. Meetings at 6:30 P.M. on fourth Monday of each month from October to April, inclusive.

*Radiological Society of the Academy of Medicine (Cincinnati Roentgenologists).*—Secretary-Treasurer, Samuel Brown, M.D., 707 Race St. Meetings held third Tuesday of each month.

## PENNSYLVANIA

*Pennsylvania Radiological Society.*—Secretary-Treasurer, L. E. Wurster, M.D., 416 Pine St., Williamsport. The Society meets annually.

*The Philadelphia Roentgen Ray Society.*—Secretary, Robert P. Barden, M.D., 3400 Spruce St., Philadelphia. Meetings held first Thursday of each month at 8:15 P.M., from October to May, in Thomson Hall, College of Physicians, 21 S. 22nd St., Philadelphia.

*The Pittsburgh Roentgen Society.*—Secretary-Treasurer, Reuben G. Alley, M.D., 4800 Friendship Ave., Pittsburgh, Pa. Meetings are held on the second Wednesday of each month at 4:30 P.M., from October to June, at the Pittsburgh Academy of Medicine, 322 N. Craig St.

## ROCKY MOUNTAIN STATES

*Rocky Mountain Radiological Society* (North Dakota, South Dakota, Nebraska, Kansas, Texas, Wyoming, Montana, Colorado, Idaho, Utah, New Mexico).—Secretary, A. M. Popma, M.D., 220 North First St., Boise, Idaho.

## SOUTH CAROLINA

*South Carolina X-ray Society.*—Secretary-Treasurer, Robert B. Taft, M.D., 103 Rutledge Ave., Charleston. Meeting in Charleston on first Thursday in November, also at time and place of South Carolina State Medical Association.

## TENNESSEE

*Memphis Roentgen Club.*—Chairmanship rotates monthly in alphabetical order. Meetings second Tuesday of each month at University Center.

*Tennessee Radiological Society.*—Secretary-Treasurer, J. Marsh Frère, M.D., 707 Walnut St., Chattanooga. Meeting annually with State Medical Society in April.

## TEXAS

*Texas Radiological Society.*—Secretary-Treasurer, Herman Klapproth M.D., Sherman.

## VIRGINIA

*Virginia Radiological Society.*—Secretary, E. Latané Flanagan, M.D., 215 Medical Arts Bldg., Richmond.

## WASHINGTON

*Washington State Radiological Society.*—Secretary-Treasurer, Thomas Carlile, M.D., 1115 Terry Ave., Seattle. Meetings fourth Monday of each month, October through May, at College Club, Seattle.

## WISCONSIN

*Milwaukee Roentgen Ray Society.*—Secretary-Treasurer, C. A. H. Fortier, M.D., 231 W. Wisconsin Ave., Milwaukee. Meets monthly on second Monday at the University Club.

*Radiological Section of the Wisconsin State Medical Society.*—Secretary, Russell F. Wilson, M.D., Beloit Municipal Hospital, Beloit. Two-day annual meeting in May and one day in connection with annual meeting of State Medical Society, in September.

*University of Wisconsin Radiological Conference.*—Secretary, E. A. Pohle, M.D., 1300 University Ave., Madison, Wis. Meets every Thursday from 4 to 5 P.M., Room 301, Service Memorial Institute.

## CANADA

*Canadian Association of Radiologists.*—Honorary Secretary-Treasurer, A. D. Irvine, M.D., 540 Tegler Bldg., Edmonton, Alberta.

*La Société Canadienne-Française d'Électrologie et de Radiologie Médicales.*—General Secretary, Origène Dufresne, M.D., Institut du Radium, Montreal. Meetings are held the third Saturday of each month, generally at the Radium Institute, 4120 East Ontario Street, Montreal; sometimes, at homes of members.

## CUBA

*Sociedad de Radiología y Fisioterapia de Cuba.*—Offices in Hospital Mercedes, Havana. Meetings are held monthly.



## ROENTGEN DIAGNOSIS

### THE HEAD AND NECK

**Mechanism of Phonation Demonstrated by Planigraphy of the Larynx.** Bruno L. Griesman. *Arch. Otolaryng.* 38: 17-26, July 1943.

Planigraphy has been found by the author to be of considerable value in the study of the physiology of the larynx during phonation. Planigrams demonstrating the four phases of sound production are reproduced. All of the planigrams were made at a depth of 2 cm. behind the Adam's apple. They show a gross movement downward of the entire larynx during the production of the low octave sound and a reverse movement upward during the production of the higher notes. The author's studies demonstrate that "the primary function of the larynx as a sphincter valve plays also an important role secondarily in the production of voice."

Before the development of planigraphy, it was difficult to get an idea of the lower aspect of the vibrating vocal cords and the contours of the resonating tubes. The author believes that, in the examination of patients with voice disorders, planigraphy will have the advantage over laryngoscopy and photography of the larynx of showing how the resonating cavities act, and not the vocal cords alone.

The paper is well illustrated.

**Sarcoma of the Tonsil. Impressions Made by Seven Cases.** C. A. Whitcomb. *Arch. Otolaryng.* 38: 1-9, July 1943.

The author made a study of 7 cases of sarcoma of the tonsil, which he presents briefly in tabular form, with his observations. This is not a common tumor and should not be confused with squamous-cell carcinoma of the anterior faucial pillar, the most common malignant neoplasm in the region of the tonsil. The latter is a slowly growing tumor, which almost never metastasizes beyond the regional lymph nodes of the neck, and kills by pain and starvation. Sarcoma of the tonsil grows rapidly, spreads quickly and widely, and kills by visceral metastasis. Since small cancers of the anterior pillar can be cured by surgical excision, it is especially important to differentiate between these two types of tumor.

Sarcoma of the tonsil has the same gross characteristics as sarcoma arising in other parts of the body. It appears as a bulky, rapidly enlarging, elastic mass, which displaces adjacent tissue. It cannot be distinguished by physical examination from the other types of neoplasm of the tonsil, namely, squamous-cell carcinoma, lymphoepithelioma, and transitional-cell carcinoma, but requires microscopic examination of an adequate biopsy specimen for its identification. Repeated biopsies may be necessary for a correct diagnosis. All metastases should be located by careful physical and roentgen examinations.

Tonsillar sarcoma and its regional metastases are treated with roentgen rays or radium, or with a combination of the two. The primary tumor receives daily doses of roentgen rays of moderately short effective wave length, in a fraction of the amount which reddens the skin. The radiation is delivered through an intratonsillar cone and through the skin of the neck overlying the tonsil. The treatments are continued until a diphtheritic membrane covers the tonsil. For radium

therapy, radon, confined in tiny lengths of capillary gold tubing with a wall 0.3 mm. thick, may be permanently placed at intervals 1 cm. apart in the tumor and the surrounding tonsil. Seeds may also be used to supplement a smaller dose of roentgen rays than that which causes blistering of the skin. The combined method of irradiation offers the advantages of the diffuse radiation effect of roentgen rays and the more intense local effect of radon seeds.

Metastases in the lymph nodes of the neck are treated with daily fractional doses of roentgen rays, supplemented with gamma radiation if the masses persist. Roentgen radiation may be given for relief of symptoms produced by thoracic, abdominal, and skeletal metastases.

The prognosis in sarcoma of the tonsil is poor, especially if cervical metastases are present before treatment. In the author's series all of the patients died of distant metastases.

### THE CHEST

**Adequacy of the Photofluorographic Method of Chest Survey.** M. W. Mason. *Ohio State M. J.* 39: 830-832, September 1943.

The author has found both the 4 × 5-inch and the 35-mm. film photofluorographic methods of chest survey adequate from the standpoints of cost, speed, filing, and accuracy. On the basis of his experience in reading 2,000 4 × 5-inch films and over 250,000 35-mm. films, he states a preference for the former, since the larger size involves less eye-strain and insures more accurate diagnosis.

In two average months at the Great Lakes Naval Station, 41,616 men were examined with 35-mm. film; 317 of these were re-examined by 14 × 17-inch films, and 112 finally referred to the hospital for further study. The original diagnosis was changed in only 16 instances.

A table presents the results of 270,060 examinations with 35-mm. films. The number of abnormal findings was 24,108, of which 18,634 represented pulmonary tuberculosis, active and inactive. The number of rejections for service on the basis of the x-ray findings was 954 or 0.35 per cent.

LESTER M. J. FREEDMAN, M.D.

**Interrelationship of Upper and Lower Respiratory Infections, Emphasizing the Routes of Infection.** John G. McLaurin. *Ann. Otol., Rhin. & Laryng.* 52: 589-597, September 1943.

The author believes that, with the exception of specific types of lung infection—tuberculosis, syphilis of the lungs, pneumonia, and lung abscesses resulting from foreign bodies or from the aspiration of infected tissue or material at operation—85 to 100 per cent of all cases of chronic tracheobronchitis, bronchitis, bilateral bronchiectasis, and peribronchitis are directly dependent upon some type of chronic sinus disease. Chronic sinus disease must consequently be looked upon as a constant menace to the lungs.

The most probable routes by which infection reaches the chest from the diseased sinuses are as follows: (1) direct aspiration of infectious material into the trachea and bronchial tree, so-called aspiration or droplet infection; (2) lympho-hematogenous extension; (3)

hematogenous extension; (4) direct continuity of tissue. Usually a combination of routes is involved.

To demonstrate the role of aspiration infection, the author twice injected the ethmoid and sphenoid sinuses with lipiodol, with a twenty-four-hour interval. A film of the chest immediately after the first injection showed lipiodol in the bronchi, and twenty-four hours later some of the material was still demonstrable in the smaller bronchioles. This experiment, conducted on patients up and "about their business," would indicate that the larynx is not always effective in blocking the course of a foreign material. This being the case, it seems reasonable to assume that mucopurulent material, manufactured by the patient's own tissues, would even more readily find its way from the postnasal space into the bronchial tree.

Experiments by others have demonstrated the lympho-hematogenous route of infection (Mullin and Ryder: *Laryngoscope* 31: 138, 1921), but experimental studies on hematogenous spread do not seem to have been conducted. Infection by direct continuity is believed to be less common than by the other routes.

STEPHEN N. TAGER, M.D.

**Tuberculous Tracheobronchitis.** David McCulloch. *Dis. of Chest* 9: 448-454, September-October 1943.

The author quotes Alexander's figure (*J. Thoracic Surg.* 11: 308, 1942) of 11 per cent as representative of the incidence of tuberculous tracheobronchitis in pulmonary tuberculosis. Acute lesions may be hyperplastic, ulcerative, or both. The chronic lesion is a smooth fibrostenosis. Smaller bronchi leading from cavities are almost uniformly involved, while the larger bronchi and trachea may be the site of disease varying from a slight area of mucosal redness to ulceration and fibrous stenosis. Following the healing of an ulcerative lesion which has partly destroyed the cartilage, a portion of the bronchus may be relatively flaccid, with the result that during the expiratory phase the bronchial wall collapses, impeding the passage of air. The problem of tuberculous tracheobronchitis is thus one of mechanical obstruction and improper drainage of secretions distal to the site of the disease. The latter may be due to loss of ciliary action and impairment of bronchial peristalsis as well as to mechanical obstruction. Obstructive emphysema, atelectasis, and bronchiectasis may supervene.

One of the chief symptoms of tuberculous tracheobronchitis is severe and often paroxysmal cough: expectoration may be scanty and mucoid, later abundant and purulent, with persistent streaking. Wheezing, asthma-like attacks, intermittent fever, dyspnea and cyanosis may occur.

The roentgen findings are usually indirect: atelectasis, check valve cavities with fluid levels, localized emphysema, spontaneous closure of cavities, unexplained spread of disease in the absence of cavitation. Mural involvement of a larger bronchus, encroaching upon the lumen, may be demonstrated by bronchography. A positive diagnosis can be made only by bronchoscopy, but a negative bronchoscopy does not exclude the possibility of disease in the smaller bronchi.

Local treatment through the bronchoscope is sometimes effective in the ulcero-hyperplastic type of lesion. Lobectomy, pneumonectomy, and thoracoplasty have been advocated in stenotic lesions.

HENRY K. TAYLOR, M.D.

**Primary Atypical Pneumonia, Etiology Unknown.** John H. Dingle et al. *War Med.* 3: 223-248, March 1943.

This paper, which is a report of clinical, epidemiologic, and etiologic studies of atypical pneumonia at Camp Claiborne by the Commission for the Investigation of Atypical Pneumonia and Other Respiratory Diseases, is based on 69 cases observed by members of the Commission and 216 cases abstracted from hospital records. The results of these studies are in general agreement with the observations of other investigators. The disease is characterized by gradual onset, moderately severe constitutional and respiratory symptoms, minimal physical signs in the lungs, and a febrile course of approximately one week's duration. The infection occurs in epidemic and in endemic form. The causation has not been ascertained; on the basis of this investigation it seems most likely that a virus is responsible.

The most characteristic feature of the syndrome, clinically, was the late development of physical signs in the lungs, in contrast to the comparatively extensive roentgen findings. The first change to be noted, early in the course of the illness, was an increase in the size of the hilar shadow, unilaterally or bilaterally. Perihilar infiltration became increasingly apparent in subsequent films, and the shadow then extended toward the periphery of the lung field in either a wedge or a fan shape, usually fading into the normal parenchyma of the lung before reaching the periphery. Spread of the lesion often occurred within a lobe or to an adjoining lobe, but rarely was an entire lobe involved. In some instances the process appeared to be confined to a local area, such as a portion of an upper lobe; in others diffuse seeding of one or both pulmonary fields occurred. In still others infiltration extended along a septum and appeared to be limited by it or was diffuse and became irregularly confluent.

The infiltration usually appeared to be soft and either patchy or homogeneous in character; the greatest density was near the hilus. The pulmonary markings were usually visible, although the outlines of the vascular and bronchial shadows were frequently indistinct. The degree of change in the roentgen appearance of the lesions over a period of a few days was one of the most striking features. Occasionally the lesions were transitory and were seen for only three or four days. Usually, however, the lesion progressed as described and then underwent slow resolution over a period varying from one to three weeks. The enlarged hilar shadows and increased pulmonary markings occasionally persisted for several weeks.

**Virus Pneumonia: Etiological Studies.** Monroe D. Eaton. *California & West. Med.* 59: 160-162, September 1943.

The designation "atypical pneumonia" is generally used to denote a primary pneumonitis or bronchopneumonia without known bacterial etiology. In only about 10 per cent of all cases is a causative virus demonstrable, and it is with this group that the present paper is concerned. Four types, each dependent upon a different virus, are recognized.

Pneumonia may be produced by (1) either of two antigenically distinct viruses of influenza, designated A and B; (2) by the virus of Q fever, of rickettsial origin; (3) by the psittacosis virus; (4) by a virus isolated by the author from cases of severe atypical

pneumonia. Influenzal pneumonia caused by the type A virus, so far as is now known, occurs only in association with epidemics of uncomplicated influenza due to the same virus. The occurrence of Q-fever pneumonitis in the United States is limited to laboratory infections, while the psittacosis type is associated in most instances with contact with infected birds.

The virus isolated by the author is a member of a group which includes not only the psittacosis virus but also the virus of lymphogranuloma venereum, that of meningopneumonitis, and that of mouse pneumonitis recently isolated by Nigg (*Science* 95: 49, 1942). The members of this group are characterized by the formation of minute coccoid elementary bodies, by the possession of common antigenic components, and by similarities in pathogenicity for experimental animals.

Despite the fact that the complement-fixation test with this group of viruses was not specific for any one member of the group, when applied to human serum, the author considered it of interest to determine what proportion of cases of atypical pneumonia and of uncomplicated upper respiratory disease gave the reaction. For this purpose, antigens from the viruses of lymphogranuloma venereum and meningopneumonitis were used. In 5 of 17 cases of pneumonitis tested with the virus of meningopneumonitis the convalescent serum showed a definite increase in titer of 8-fold or greater over the serum taken in the acute stage of the illness. Similar definite increases were observed in 6 out of 61 cases tested with the virus of lymphogranuloma venereum. In other cases increases in titer of lesser degree were observed. One case of upper respiratory disease with influenzal symptoms showed a definite increase in titer with both antigens. This case gave negative serological tests for influenza types A and B. In a few other cases of upper respiratory disease slight increases were observed.

Pneumonia attributable to the author's virus appears to be of rare occurrence. The virus was isolated from only 2 out of 106 sputum specimens, and 3 of 14 specimens of lung tissue inoculated into mice intranasally. No transmissible agent could be found in sputum from a number of patients whose serum gave positive reactions with meningopneumonitis antigen.

MAURICE D. SACHS, M.D.

**Primary Atypical Pneumonia and Malaria.** Edgar T. Campbell. *War Med.* 3: 249-255, March 1943.

Primary atypical pneumonia is frequently complicated by a concurrent malaria in localities where the latter disease is endemic. Fifty cases in which the two diseases occurred in association are reported by the author. Some patients who are admitted to the hospital with primary atypical pneumonia are subsequently found to have a blood smear positive for malarial parasites; others are admitted for malaria and later have atypical pneumonia.

In the first group, the onset is usually gradual; there may be a non-productive cough, vague pains in the chest, sore throat, and intermittent fever. The temperature averages between 100 and 102° F. Positive physical signs throughout the illness remain at a minimum. A roentgenogram is necessary for an early and accurate diagnosis of atypical pneumonia. Approximately 68 per cent of the patients in this group had blood smears positive for malaria parasites. This "secondary infection" seemed to have little or no effect

on eventual recovery except that longer hospitalization was required to eradicate the parasite than for the pulmonary infection alone.

Patients of the second group are usually admitted to the hospital complaining of a sudden onset of chills and fever or one of the other manifestations of beginning malaria. Blood smears are found to be positive for malarial parasites and antimalaria therapy is begun. During convalescence, a non-productive cough may develop, with pain and discomfort in the chest and elevation of temperature. Examination may or may not reveal positive physical signs in the chest. The diagnosis of atypical pneumonia is made by roentgen examination. As in the first group, each disease runs its independent course, with little effect on the eventual recovery of the patient.

**Roentgenologic Appearance of "Bronchiogenic" Cysts.** Laurence L. Robbins. *Am. J. Roentgenol.* 50: 321-333, September 1943.

Bronchiogenic cysts are usually incidental findings and only occasionally produce symptoms. Fifteen proved cases were selected by the author from the records of the Massachusetts General Hospital, and the case reports are given. The difficulty of diagnosis is shown by the fact that in only 4 of the 15 was the correct diagnosis suggested in the preoperative roentgenologic report. Preoperative differentiation from lung abscess, encapsulated empyema, neurofibroma, dermoid, lymphoma, and malignant tumor is difficult, and in some instances impossible.

The roentgenologic examination should always include roentgenoscopy. At least postero-anterior and lateral views of the chest are necessary. Barium examination of the esophagus is important. It should be remembered that cysts, even if lying within the mediastinum, may show a fluid level, as a bronchus often connects with the cyst. In such cases the roentgenologic appearance of a fluid-and-air-filled cavity suggests a lung abscess. The cyst may alternately fill with fluid or drain and contain air.

The roentgen diagnosis of bronchiogenic cysts is dependent (a) on the finding of a smooth, round or ovoid mass arising from the mediastinum without evidence of bone erosion or calcifications within the wall. Additional proof may be found in the demonstration of tracheal attachment or intramural, extramucosal involvement of the esophagus. (b) Those cysts which are infected simulate lung abscess in appearance.

Because of the difficulty in diagnosis and the technical difficulties after infection has developed, operative interference is generally recommended.

CLARENCE E. WEAVER, M.D.

**Bronchogenic Carcinoma.** Foster Murray. *Dis. of Chest.* 9: 383-402, September-October 1943.

The author believes there has been a definite increase in the occurrence of primary pulmonary malignant tumors, the majority of which are carcinomas of bronchogenic origin. They occur most often between the ages of 40 and 60, and predominantly in males (8 to 1). The neoplasms are invasive, destructive, and obstructive, with a tendency to ulcerate, erode, become infected, and metastasize. There are three types: (1) squamous-cell (epidermoid, epithelioma), accounting for about 42 per cent; (2) small-cell (including the undifferentiated-cell, oat-cell, and transi-

tional-cell types), comprising about 33 per cent; (3) adenocarcinoma, representing the remaining 25 per cent.

Chronic irritation supervening upon a constitutional defect is given as the etiologic factor. The symptoms, which depend upon the size, location, and type of the new growth, include cough and expectoration, pain, dyspnea, wheeze; anorexia, loss of strength and weight, fever, hemoptysis, pressure effects, anemia, cachexia, secondary infections, and suppuration. Pleural effusion appears in about one-third of the cases. The onset is usually insidious, though it may be rapid and mistaken for a pneumonia.

Metastasis occurs to the regional lymph nodes (tracheobronchial, paratracheal, supraclavicular, cervical, and axillary), and to liver, lungs, bones, kidneys, adrenals, pleura, brain, and female pelvic adnexa.

Points to be observed on fluoroscopic examination are (1) elevation of the diaphragm on the side of the tumor, (2) paradoxical movement of the diaphragm, (3) mediastinal shift during respiration, (4) absence of expansile pulsation if the mass is adjacent to the aortic arch, and (5) effusion. Roentgenograms reveal the site and size of the mass and the presence of bronchial occlusion, effusion, and metastases. Bronchography will localize the closed bronchus, and tomography may be helpful, not only in clearly delineating the mass or the cavity within it, but in more definitely locating the position of the growth relative to the anteroposterior planes.

Bronchoscopy may reveal a fixation of the mediastinum, widening of the carina, deformity of the bronchial walls, and an endobronchial mass. It also provides the best and safest means of obtaining a biopsy specimen.

Other aids in arriving at a diagnosis are lung puncture—though this is condemned by some clinicians—pneumothorax and thoracoscopic exploration, and biopsy of a superficial node. Exploratory thoracotomy is justifiable when other methods of obtaining biopsy material have failed.

The group of squamous-cell tumors is the only one which offers any measure of success following lobectomy or pneumonectomy. HENRY K. TAYLOR, M.D.

**Byssinosis—Report of Two Cases and Review of Literature.** H. Leonard Bolen. *J. Indust. Hyg. & Toxicol.* 25: 215-224, June 1943.

Byssinosis is the term used to identify a form of respiratory disease affecting workers in cotton mills, where much dust is given off in the early processes of preparing the cotton for spinning and weaving.

The onset of byssinosis is insidious. The victim sneezes frequently, has a slight, dry, increasingly irritating cough and is aware of a feeling of constriction in the chest. There is a rise in temperature (101-103°), which may last for two or three days, and dyspnea occurs. The appetite remains good; the patient sleeps well and is able to work. Symptoms are more acute on Mondays, when the worker resumes his dusty occupation after 36 hours in a clean atmosphere.

As the fine particles of cotton become lodged in the lungs, an irritation is set up, the breathing becomes more labored, and the cough more metallic. Expectoration is difficult. The worker becomes easily fatigued and is forced to refrain from work several days at a time. When out of the dusty atmosphere, improvement is rapid.

The disease progresses, with individual variation, over a period of years. As the cotton dust makes its way into the finer bronchi, there is a considerable decrease in vital capacity. The victim becomes a semi-invalid and is forced to give up work. Prolonged exhausting attacks of coughing and the sensation as of a constricting band about the chest cause weakness and loss of weight. As the action of the diaphragm becomes restricted, the sternum becomes prominent, and the chest assumes a barrel shape. The clinical picture is that of severe bronchitis and emphysema.

X-ray films in cases of byssinosis are rare, as investigation of this condition has been recent. In both of the cases here reported, roentgen examination of the chest showed extensive fibrosis. The roentgenograms are reproduced.

There is no specific treatment for byssinosis. Removal from exposure should be the first step, if the worker appears to be susceptible, and symptomatic or preventive treatment should be instituted. In the last stages of the disease, treatment can be only palliative, because irreversible structural changes have taken place in the lungs. Precautionary measures should be taken in textile plants to control card-room dust. Workers should be examined periodically, and those showing pulmonary symptoms should be advised to seek work in another environment.

A bibliography is appended.

**Study of Industrial Workers Exposed to Sulfur Dust.** Sherman S. Pinto, R. Alec Brown, and B. Hardy Carlton. *J. Indust. Hyg. & Toxicol.* 25: 149-151, April 1943.

A study was made of the workers in a sulfur mine employing 500 people. Although the only employees of this company who are exposed to sulfur dust in appreciable amounts are those who remove the material from stockpiles and load it onto barges and those who handle it at the point of transshipment, it was decided to x-ray all employees. The examination was entirely voluntary, and some workers were not studied. Of the latter group, however, none was exposed to sulfur dust. Chest x-rays with a 35-mm. photofluorographic unit were made of 430 people. Each person showing any lung abnormality was re-examined, using a 14 X 17-inch film, with no significant differences in the findings. Among the workers exposed to appreciable amounts of sulfur dust for a period of seven years, no lung lesions were found on x-ray examination which could be attributed to inhalation of the dust.

**Agenesis of Lung in an Infant.** Charles T. Olcott and Samuel W. Dooley. *Am. J. Dis. Child.* 65: 776-780, May 1943.

A case of complete absence of the right lung in a female infant 2 months old is reported. From birth, a gurgling sound was noticed with respiration, and there was pronounced retraction of the sternum and ribs on crying. The thorax was normally formed and symmetric but there was a respiratory lag on the right side. The trachea appeared to be deviated to the right of the mid-line, and percussion demonstrated dullness throughout the right hemithorax. No adventitious sounds were heard except an occasional tracheal gurgle. The point of maximum intensity of the heart beat was at the right nipple and the electrocardiogram showed changes considered compatible with displacement of

the heart. On roentgenographic examination, the cardiac silhouette and mediastinal contents were found in the right side of the chest, continuous with the shadow of the liver. The right bronchus was not demonstrable. Bronchoscopy confirmed its absence and that of the carina. The child died of pneumonia, and autopsy confirmed the diagnosis of pulmonary agenesis. No right pleural cavity was present.

The authors review the literature and call attention to the fact that major anomalies in the respiratory system are less frequent than in the kidneys, genital organs, or digestive tract. In over 10,000 necropsies at the New York Hospital, including many performed on newborn infants, there has been no previous instance of absence of a lung. About 52 cases of complete absence of one lung have been adequately described in the literature.

**Thymic Tumor in Myasthenia Gravis: A Case Report.** Elmer Haynes. *Wisconsin M. J.* 42: 932-933, September 1943.

A case of myasthenia gravis is reported in a 42-year-old man, proved clinically by relief of eye muscle symptoms 15 minutes following the subcutaneous injection of 3 mg. of prostigmine and 1/150 gr. of atropine sulfate. No chest roentgenogram was made since no abnormal chest signs were present. After six years of fairly good health under treatment, the patient was readmitted to the hospital in a semicomatose condition and died. Autopsy showed a soft, gelatinous, cystic mass measuring  $17 \times 10 \times 8$  cm. in the thymic area, with several similar nodules, up to 0.7 cm. in diameter, on the right pleura. Microscopic examination showed proliferation of reticulo-endothelial cells, areas of small lymphocytes, and atrophied thymic tissue. Striated muscle sections showed atrophy, hyaline degeneration, and patches of lymphocytic infiltration.

In view of the favorable results reported following the use of roentgen therapy and thymectomy, it is suggested that chest roentgenograms be made routinely in all cases of myasthenia gravis. A negative roentgenographic report does not, however, necessarily rule out thymic enlargement.

LESTER M. J. FREEDMAN, M.D.

**Roentgenologic and Electrocardiographic Changes in the Normal Heart During Pregnancy.** A. Gerson Hollander and J. Hamilton Crawford. *Am. Heart J.* 26: 364-376, September 1943.

A survey was undertaken on healthy women in order to determine whether the enlargement of the cardiac shadow frequently observed in pregnancy is due to cardiac hypertrophy with or without dilatation, or to rotation and displacement. The women were under observation both during and after pregnancy. Roentgen examinations of the chest in the postero-anterior, right and left oblique projections, and esophagrams were made every three months during pregnancy, and again one or two months post-partum. Electrocardiographic tracings were made at four-week intervals, using the two-string electrocardiograph, recording simultaneously Leads I and III. The findings in 18 cases are given.

The most outstanding changes in the electrocardiogram were confined to Lead III. A prominent and, at times, deep Q wave and inversion of the T wave were present in 5 cases, and the T wave became negative and then positive post-partum without alteration of the Q

wave in 4 cases. No abnormalities of QRS or the RS-T segments appeared. Although there was no absolute or invariable rate of electrical axis deviation, there was nevertheless a tendency to a shift toward the left during the first and second trimesters of pregnancy, followed by a swing to the right.

The most frequently observed roentgen abnormality was encroachment upon the anterior surface of the esophagus in the region of the left auricle. In the majority of cases the esophagus as a whole was not displaced but a definite indentation of the anterior wall was seen. This finding usually disappeared after the thirty-fourth week of pregnancy. Straightening of the left border of the cardiac silhouette was observed in 2 instances, prominent pulmonary conus in 3, and elevation of the left main bronchus in one.

The authors attribute the roentgen changes observed during pregnancy to an increase in blood volume within the heart, and not to cardiac hypertrophy. The electrocardiographic changes are explained as the result of a positional shift. HENRY K. TAYLOR, M.D.

**Heart Size and Pulmonary Findings During Acute Coronary Thrombosis.** Edward Massie and Wallace C. Miller. *Am. J. M. Sc.* 206: 353-360, September 1943.

Sixteen cases of undoubted acute coronary thrombosis were studied by teleroentgenograms taken at frequent intervals following the acute attack, with particular reference to the size of the heart and the presence of pulmonary congestion. All films were made at a distance of 5 feet, with the patient sitting up. The cardiothoracic ratio was used as a measurement of heart size. All patients were studied by roentgenkymography on the twenty-eighth day after admission. Careful clinical observations, electrocardiograms, blood pressure readings, blood counts, and other pertinent data were obtained in all cases. Excluding 2 cases in which death occurred at the end of the first week, the observations ranged from three to seven months after the attack.

Twelve of the patients had anterior, and the remainder posterior, wall infarctions. Eight had enlarged hearts initially; in 5 the hearts were at the upper limits of normal and in 3 unquestionably normal. Six of the kymograms showed decreased pulsations at the left border near the apex.

No consistent changes in cardiac size or shape were noted. Eight patients showed no change in any film of the entire series. In each of 4 other cases one film showed cardiac measurements significantly different from others of the series. These were taken at greatly varying intervals; some showed increasing and others decreasing measurements.

In the important first two weeks following the thrombosis only 4 patients showed a change in cardiac measurements, an increase in 2 and a decrease in 2. It may be significant that complications occurred more frequently in the group showing a change in heart size; these patients were somewhat more ill than the others.

Only 4 of the patients had clear lungs roentgenographically. The rest showed either fine or coarse diffuse mottling, usually at each base, or definite cloudiness in one or both bases. The pulmonary congestion was usually maximal in the first week and tended to decrease or disappear in the second. In only half of these patients could râles be heard.

BENJAMIN COLEMAN, M.D.

**Roentgen Signs of Patent Ductus Arteriosus: Summary of 50 Surgically Verified Cases.** Mark S. Donovan, Edward B. D. Neuhauser, and Merrill C. Sosman. *Am. J. Roentgenol.* 50: 293-305, September 1943.

The roentgen findings in 50 cases of patent ductus arteriosus which were verified by operation are presented. These findings, in order of frequency, are: (a) dilatation of the pulmonary artery; (b) cardiac enlargement; (c) dilatation of the left auricle; (d) engorgement of the intrapulmonary vessels; (e) exaggerated pulsation of the left ventricle and the pulmonary artery; (f) "hilar dance," or pulsation of the vessels in the hila of the lungs.

As in all types of heart disease, roentgenoscopy is the most important part of the roentgen study and should precede the making of roentgenograms. A teleroentgenogram should be taken in the postero-anterior projection, as well as roentgenograms in both the left and right anterior oblique positions. A roentgenkymogram may give added information and will be of value for comparison with postoperative kymograms giving evidence of the relatively calm left ventricle after ligation.

The largest hearts were seen in patients with subacute bacterial endocarditis or endarteritis. The rest had no enlargement or only slight to moderate enlargement, limited to the left side. A dilated left auricle is one of the commonest signs of a patent ductus arteriosus and in the authors' experience is exceeded in frequency only by cardiac enlargement and enlargement of the pulmonary artery. An enlarged pulmonary artery is one of the most frequent signs of congenital heart disease and it was present in the majority of the cases in this series. Marked enlargement is seldom seen. A large pulmonary artery, especially if combined with a fairly marked or extreme enlargement of the heart, is apt to be due to a combination of congenital anomalies. Accentuated pulsation of the left ventricle and the pulmonary artery was seen in about two-thirds of the cases. Angiocardiographic studies were carried out in 5 cases. In no instance were the authors able to visualize the ductus arteriosus. Evidence of recirculation of the dye through the pulmonary vessels was, however, obtained.

Roentgenoscopy and kymograms after closure of the ductus will show a reduction of the ventricular pulsation to the normal amplitude, the pulmonary artery no longer enlarged and pulsating, absence of hilar dance, and the left auricle either reduced in size or normal. There is seldom any great decrease in the transverse diameter of the heart.

The authors conclude that a patent ductus arteriosus can now be safely ligated or completely divided, which places it among the curable forms of heart disease. Its accurate diagnosis is therefore vastly more important than it formerly was.

CLARENCE E. WEAVER, M.D.

**Angiocardiography in Congenital Heart Disease: III. Patent Ductus Arteriosus.** M. F. Steinberg, A. Grishman, and M. L. Sussman, *Am. J. Roentgenol.* 50: 306-315, September 1943.

Twenty-seven cases of patent ductus arteriosus were studied by means of angiocardiography. The method employed called for the rapid intravenous injection of 70 per cent diodrast solution (Winthrop), as described by Robb and Steinberg (*J. Clin. Investi-*

*gation* 17: 507, 1938). The position of choice for roentgen examination was found to be the left anterior oblique, 50 to 70 degrees.

The following deviations from the normal were observed: (1) a distinct localized dilatation of the descending aorta just beyond the isthmus (a small bulge or a more or less uniformly dilated segment may be seen); (2) an elevation of the main and left pulmonary arteries; (3) dilatation of the main and major branch pulmonary arteries; (4) varying degrees of left ventricular dilatation.

Of the 27 cases of patent ductus arteriosus studied angiocardiographically, 26 showed the aortic abnormality described. Twelve of these cases were proved at operation. This abnormality has not been seen by the authors except in patent ductus arteriosus. It is therefore probably characteristic of that condition. The persistence of the aortic dilatation after operation might be interpreted as indicating the presence of a traction aneurysm. (The ductus is a short structure, usually no longer than 1 cm.) Prominence of the pulmonary artery segment in the conventional roentgenogram does not always indicate dilatation of the pulmonary artery. Elevation of the pulmonary artery may by itself account for this appearance.

CLARENCE E. WEAVER, M.D.

**Constricting Double Aortic Arch: Report of a Case.** Peter A. Herbut and Thomas T. Smith. *Arch. Otolaryng.* 37: 558-562, April 1943.

A case of a constricting double aortic arch incompatible with prolonged life is reported.

A girl aged 2 1/2 months was admitted to the hospital with a history of increasing respiratory difficulty. Physical examination revealed nothing of significance and roentgen studies showed a normal chest with little or no increase in the breadth of the upper mediastinal shadows. On the third day of hospitalization, while feeding, the infant was seized with a severe attack of coughing and dyspnea. After this, some indrawing of the suprasternal and intercostal spaces persisted, and the respirations never again became entirely normal. The child lay with her head turned to the left at all times. When the head was forcibly turned to the right, her breathing became more difficult and indrawing was marked. When she was placed in the Boyce position preparatory to direct laryngoscopic examination, increased respiratory difficulty was noted. Upon extension of the head, in order to introduce the laryngoscope, respiration ceased entirely, indicating increased tracheal obstruction. The larynx, however, appeared normal. After laryngoscopy, respirations began only when the child was held with the neck extended and with flexion of the head on the neck. A low tracheotomy was performed, several cubic centimeters of thick pus were aspirated, and the patient experienced some relief. When a small rubber aspirating catheter was passed through the tracheotomic cannula, an obstruction was encountered below the end of the cannula, about 1 cm. below the suprasternal notch. The catheter would pass this narrowing only with difficulty. Death occurred on the second day following tracheotomy, the fifth day of hospitalization.

Necropsy revealed the ascending aorta anterior to but slightly to the right of the trachea. At its superior portion it bifurcated into a larger right and smaller left aortic arch, measuring 1.0 cm. and 0.5 cm. in diameter, respectively. Each was directed dorsally,

lateral to the trachea and esophagus and superior to the hilus of the corresponding lung. Posterior to the esophagus the arches united, forming a complete arterial collar encircling the trachea and esophagus. The descending aorta was situated slightly to the left of the mid-line. The great vessels of the neck and upper extremities arose almost symmetrically from each arch. There was no innominate artery.

The author believes that when symptoms and findings such as were present in this case are encountered, the possibility of a constricting double aortic arch should be kept in mind, as the roentgenologist, once his attention is directed to this unusual condition, can offer considerable aid in diagnosis. He not only can rule out most other possible causes but will be able to demonstrate a number of rather conclusive features. The broadening of the superior mediastinal shadows, often very slight, can be investigated thoroughly. The esophageal constriction at the level of the aortic arch is the most constant and the most informative manifestation. This is best demonstrated by fluoroscopic studies of the swallowing function followed by roentgenograms of the outlined esophagus. Esophagoscopy is contraindicated. If an early diagnosis is made, the possibility of successful surgical treatment is suggested.

**Tetralogy of Fallot.** Irwin Feigin and Julius Rosen-thal. *Am. Heart J.* 26: 302-312, September 1943.

The postmortem findings are given in two cases in which the hearts showed changes constituting the tetralogy of Fallot, namely, right ventricular hypertrophy, pulmonic stenosis, interventricular septal defect, and dextroposition of the aorta.

The first patient died at the age of 53. His history would lead one to believe that there was no pulmonic stenosis prior to the age of 37, although the other changes were manifestly congenital. Rheumatic pulmonic valvulitis, acquired late in life, resulted in a pulmonic stenosis, completing the tetralogy. The complex of congenital cardiac abnormalities displayed by this patient, before development of acquired pulmonic stenosis is known as the Eisenmenger complex. It is less common than the complete tetralogy, and the associated functional changes are of less serious prognostic significance.

The second patient died at the age of 43. The changes apparently had been present since birth. A communication also existed between the auricles, and a fibrous strand representing the remnants of a patent ductus arteriosus was found.

The cardiodynamics in the two cases are discussed.

HENRY K. TAYLOR, M.D.

**Treatment of Dysphagia from Hernia Through Esophageal Hiatus in Diaphragm.** Porter P. Vinson. *Arch. Otolaryng.* 38: 27-31, July 1943.

The purpose of this paper is to call attention to two types of diaphragmatic hernia, through the esophageal hiatus, in which dysphagia is often the predominating symptom. These two types of hernia are the para-esophageal and the so-called short esophageal.

In the para-esophageal type of hernia, the esophageal opening in the diaphragm is larger than normal, and a portion of the stomach, usually the fundus, protrudes alongside the esophagus into the thorax. At first this abnormality may not produce symptoms but, because of the negative intrathoracic and positive

intra-abdominal pressure, more and more of the stomach is sucked and pushed into the thorax, so that eventually symptoms occur.

In patients with the so-called short esophageal type hernia, the esophagus is usually about 2 inches shorter than average. It does not reach the diaphragm, and in the process of growth a portion of the stomach develops within the thorax.

Roentgenoscopy is almost indispensable in the diagnosis of hernia through the esophageal hiatus and in the differentiation of congenital shortening of the esophagus with hernia from paraesophageal hernia. The patient should be examined in the recumbent or the Trendelenburg position, as otherwise the hernia may be overlooked. If he swallows a few mouthfuls of a fairly thick suspension of barium sulfate while in an erect position and then a mouthful or more of the same mixture while lying down, a hernia, when present, will usually be detected and the type readily determined.

Direct visualization of the esophagus through an esophagoscope is also a useful procedure. In patients with congenital esophageal shortening with hernia, the junction of the esophagus and stomach is found at a higher level than normal. The presence of ulceration or stricture can be determined, and differentiation can be made from obstruction due to a malignant neoplasm. As the esophagoscope is passed through the area of spasm or stricture at the junction of the esophagus and stomach, gastric mucosa can be seen directly ahead of the examining tube even before the instrument enters the hernial sac if the hernia is of the short esophageal type. In a person with a normal esophagus or with cardiospasm or paraesophageal hernia, the esophagus inclines toward the left and anteriorly, so that the gastric mucosa is not seen until the tube has actually been introduced into the stomach.

Operative treatment is the procedure of choice for the paraesophageal type of hernia. For congenital shortening of the esophagus with hernia and for paraesophageal hernias in which dysphagia is a prominent symptom or in which operation is refused or deemed inadvisable, passage of dilating sounds over a previously swallowed silk thread is recommended.

## THE DIGESTIVE SYSTEM

**Emptying Time of the Normal Human Stomach in the Young Adult.** Edward J. Van Lier and David W. Northup. *Gastroenterology* 1: 279-284, March 1943.

The gastric emptying time was determined fluoroscopically in 69 healthy adult males between the ages of 20 and 30 years. The subjects were given the test meal at about 8:30 in the morning, having eaten nothing since the previous evening, and were instructed to relax both mentally and physically as much as possible. The meal consisted of 15 gm. of Quaker Farina boiled in 350 c.c. of water until the volume was reduced to 200 c.c. Fifty grams of barium sulfate were added.

The average gastric emptying time for the 69 young adults was 2.13 hours, the median 2.08 hours, and the mode 2.09 hours. The extremes ranged from 1.50 to 3.30 hours.

**Peptic Ulcer at Fort George G. Meade, Md.** Charles A. Flood. *War Medicine* 3: 160-170, February 1943.

Seventy-five soldiers with peptic ulcer (71 duodenal, 4 gastric) at Fort George G. Meade were studied with



a view (a) to determining whether the digestive symptoms which persisted after treatment were due to an actual delay in the healing of the ulcer or were on a functional basis; (b) to discovering the underlying mechanism for failure of these patients to respond to treatment as they would in civilian life.

All of the patients were hospitalized. Only one-third were relieved of their symptoms within the first two weeks of treatment. Approximately one-half continued to have some gastric symptoms even after four weeks in the hospital, and the average period of hospitalization was two months. This is in notable contrast to a series of 225 civilian patients with duodenal ulcer with symptoms severe enough to require hospitalization, reported by St. John and Flood (*Ann. Surg.* 110: 37, 1939); two-thirds of this group obtained complete symptomatic relief within two weeks.

In the present series the diagnosis of ulcer was established mainly by roentgen examination. A second roentgen study after two to four weeks served to estimate the degree of response to therapy and to confirm the original diagnosis in cases in which evidence of a deformity of the duodenal cap persisted even after healing of the lesion. Three of the patients with gastric ulcer were re-examined twice. In each instance the ulcer crater was found to be of approximately the same size as on the original examination, which was interpreted as indicating a considerable delay in the healing of simple gastric ulcer.

Ulcer craters in the duodenal bulb were demonstrated in 25 of 61 patients examined shortly after admission to the hospital. Of the 25 patients with demonstrable crater, 14 were re-examined after two to three weeks of treatment and 7 of these still showed a crater, indicating that improvement had not taken place. More than half of those patients in whom the roentgen evidence of ulcer activity consisted entirely in a duodenal deformity, with associated tenderness, irritability, and spasm, showed little or no improvement after two to three weeks.

Five patients in whom a diagnosis of duodenal ulcer was made on the basis of the first roentgen examination failed to have the diagnosis confirmed when the studies were repeated. This discrepancy in the roentgen findings emphasizes the desirability of a confirmatory examination before a final diagnosis is made, especially before discharging a soldier from the Army with a certificate of disability.

Six patients in the series showed only a duodenal deformity without any direct or indirect evidence of ulcer activity. All of these patients responded to treatment promptly.

Eleven patients were members of the regular Army. Symptoms subsided completely in less than a week in 7 of this group. Follow-up roentgen studies after treatment were carried out in 6 cases and showed notable improvement in all but 1 case.

Forty-seven patients were studied from the neuropsychiatric point of view. Twenty-five of these presented symptoms of an anxiety state or an anxiety neurosis. Fourteen continued to complain of symptoms after more than a month of treatment.

The author gives his suggestions for the management of patients with ulcer in station hospitals. From a military standpoint early classification for discharge or return to limited duty is the primary objective.

From this study the following conclusions are reached: (a) Most recent inductees with ulcer re-

spond poorly to treatment, symptomatically and often roentgenologically as well. (b) In contrast to recent inductees, soldiers of the regular Army with many years of service; as a rule, respond well to treatment. They are usually of stable personality. (c) Delayed healing appears to be due in most cases to an associated anxiety state.

**Diagnosis of Perforated Ulcer. Two Useful Maneuvers by Means of Which Pneumoperitoneum and Diaphragmatic Irritation Are Demonstrated More Clearly.** Alexander E. Pearce. *Am. J. Surg.* 61: 76-78, July 1943.

The occurrence of shoulder pain as a result of diaphragmatic irritation and its exact localization, as well as the obliteration of hepatic dullness, afford valuable evidence of perforated peptic ulcer. The author describes two maneuvers for the demonstration of pneumoperitoneum and diaphragmatic irritation. With the patient supine on the x-ray table in the usual manner, a Trendelenburg position of at least 25 degrees is instituted. When there is free fluid, it flows toward the diaphragm and the patient may complain spontaneously of referred phrenic nerve pain. If there is no complaint of pain, the patient should be questioned by the examiner regarding it. Cutaneous hypersensitivity in the shoulder regions should be noted; also hepatic dullness to percussion. After several minutes, the tilt of the table is reversed, so that the head is elevated about twenty-five degrees. A small sandbag is placed beneath the right scapular angle. In this position, the gas lies anterior to the liver. Obliteration of hepatic dullness can be determined more easily because the space anterior to the right lobe of the liver represents the highest portion of the peritoneal cavity, and the gas collects there. For radiography, the head is elevated further (as close to 90 degrees as possible) so that the highest peritoneal pocket lies above the liver.

**Gastric Diverticula.** Martin L. Tracey. *Gastroenterology* 1: 518-531, May 1943.

Five cases of gastric diverticula are presented with a brief analysis of the findings in 35 cases. The symptoms in these cases were many and varied; only 4, or possibly 5, patients had symptoms that may have been attributable to the diverticulum. Associated with the diverticulum, 7 patients had duodenal ulcer, 3 carcinoma of the stomach, 2 gallstones, and 2 diverticula of the colon.

The following procedure is suggested for the diagnosis of gastric diverticulum. The stomach is carefully aspirated of fasting residue, if a gastric analysis does not precede the roentgenologic examination, and a small amount of barium or rugar, which is a rapidly spreading mixture of barium in mineral oil, is administered. The first swallow is often most important. One should be satisfied that the rugal pattern of the stomach is normal throughout, and a filled lumen will often hide outpouchings on the posterior wall. Change of position from the erect to the prone or supine is necessary to outline the cardiac area and fundus. This technic will usually reveal flecks, filling defects, or distortions of the usual mucosal pattern as well.

A diverticulum will fill out as a circumscribed, smooth pouch with little or no disturbance of normal mucosal pattern. It may not, however, fill in all positions, or may at times be prevented from filling by a fold of over-



lying tissue occluding its entrance. Films should be scrutinized for a localized, well rounded pocket of air near the gastric borders, as this may be the only roentgen finding.

Gastroscopic examination has confirmed the diagnosis and demonstrated the opening in several cases. It affords little information in a typical lesion at the cardia, and in this inaccessible area there is the possibility of perforating a diverticulum with a wide opening. During the performance of gastroscopy a surgeon capable of operating in case of a catastrophe should be within call.

Because surgery is obviously hazardous, it should be considered only if symptoms can be ascribed to the diverticulum, if obstructive symptoms intervene, if uncontrollable ulceration or neoplastic tissue within the diverticulum is suspected, or if medical treatment has failed.

**Duration of Gastric Cancer.** Walter Lincoln Palmer. *Gastroenterology* 1: 723-736, August 1943.

The inaccessibility of the stomach to direct examination makes the study of gastric cancer difficult. It is recognized, however, that this tumor, like other neoplasms, varies enormously in its rate of growth. The author presents a number of cases, ranging from the "acute" rapidly metastasizing tumor of the Jarcho type, causing death from widespread metastases in fourteen or fifteen months after the first appearance of minor symptoms, to "chronic" neoplasms. One patient studied gastroscopically and roentgenologically for four years was found at operation to have a carcinoma which was still small and without evident metastases. The "acute" and "chronic" cancers seem to be quite different, biologically, yet the basis for their difference is not clear. The "acute" neoplasms tend to be infiltrative and totally undifferentiated histologically; the "chronic" tumors tend to be circumscribed, polypoid, and histologically highly differentiated. The consensus of opinion is that the degree of cellular differentiation is the most important single prognostic factor.

The differentiation of the biologic behavior of the various gastric tumors is not a simple matter. Microscopically, in some cases, the cells are structurally undifferentiated but highly differentiated functionally. Of the patients in the series studied, 50.2 per cent of those with a tumor classification (Broder's) of Grades 1 and 2, 22.8 per cent with Grade 3, and 14.9 per cent with Grade 4, survived ten years. The rate of growth of gastric carcinoma probably depends primarily upon the growth potential of the cell, for which there is no satisfactory measure or criterion except the general knowledge that as a rule the degree of malignancy is inversely proportional to the degree of differentiation.

The author concludes that with present criteria it is hazardous to estimate the prognosis and that, as a rule, all gastric carcinomata should be resected unless there exist proved distant metastases.

**Chronic, Non-Specific Jejunitis with Unusual Features.** Walter R. Johnson. *Gastroenterology* 1: 347-353, April 1943.

A case of chronic non-specific jejunitis of unusual interest is reported. A 58-year-old Negro complained of intermittent attacks of indigestion for six years, characterized by epigastric fullness and bloating immediately after meals. At the time of one of the episodes, he had passed a large quantity of dark red

blood from the bowel, but bleeding was never noticed at any other time. Chronic constipation was present until five weeks before the patient was seen by the author; at that time diarrhea with from four to eight daily movements made its appearance. The patient became progressively weaker and lost about 40 pounds in weight.

A small, tender, freely movable mass, the size of an olive, was discovered in the left lower quadrant of the abdomen, where it could be maneuvered between the bulge of the lumbar spine and the palpating hand. A slight degree of anemia was present. No free hydrochloric acid was detected in the gastric contents.

Roentgenoscopic examination revealed an essentially normal stomach. The duodenum was dilated and contained gas. Several short segments of the upper jejunum were also enlarged and were found to contain both gas and barium. At the six-hour study these segments of jejunum still contained a large amount of barium, but only a trace remained in the stomach. Some contrast medium was found in the cecum and lower ileum, which appeared negative.

At operation a loop of grossly dilated jejunum was encountered, encircled by napkin-ring-like masses of tumor tissue, 1/2 to 3/4 in. wide. The peritoneal surface was grayish in color and covered with tags of fibrin. Some of the mesenteric nodes draining the involved areas of gut were enlarged and firm. The uppermost lesion was 3 inches below the reflection of the jejunum at the muscle of Treitz. A second napkin-ring obstruction was found perhaps 5 inches distally, and the gut between was hugely dilated and filled with secretion. At intervals of from 6 to 12 inches, five additional napkin-ring lesions were found in the upper jejunum. The entire involved area was resected. The pathologic diagnosis was chronic non-specific regional jejunitis.

This case differs from those reported by Crohn (J. A. M. A. 99: 1323, 1932). According to his observations, the disease almost invariably begins in the distal ileum and progresses proximally; obstructive phenomena are rare, and accumulation of barium in dilated upper jejunal loops does not occur. From the case reported here, it would seem the disease process may begin in the upper jejunum; progress distally; produce symptoms of obstruction; cause delayed passage of barium through dilated loops of upper jejunum, and finally remain localized to such a short segment that resection of the entire area is possible.

In his discussion of this paper, Doctor Crohn presented a case with similar findings, reported to him by Dr. Harold N. Brewster, of China.

**Nonmeckelian Diverticula of the Jejunum and Ileum.** Raymond E. Benson, Claude F. Dixon, and John M. Waugh. *Ann. Surg.* 118: 377-393, September 1943.

One hundred and twenty-two cases of nonmeckelian diverticula of the jejunum and ileum seen at the Mayo Clinic from 1909 to 1942, inclusive, are reviewed. In 100 of this series the jejunum was involved; in 17 the diverticula were limited to the ileum, and in 5 they were scattered throughout the small intestine. The proximal portion of the jejunum was most frequently affected. The majority of the diverticula were situated along the mesentery. The size varied, the average being 1 to 4 cm. in diameter. In 44 of the 122 cases only one diverticulum was observed (37 in the je-

junum; 7 in the ileum); in each of 12 cases two diverticula were present, and in the remaining 66 cases, there were three or more. Diverticula of other viscera were found in 49 of the 85 patients in this series coming to necropsy. In only one of these 85 cases were the small intestinal diverticula considered to be the probable primary cause of death.

In the majority of this series, as indicated above, the diverticula were found at necropsy; in 21 they were discovered during the course of abdominal operation, and in 16 on roentgenographic examination of the small intestine. Diagnosis by roentgenoscopic and roentgenographic examination is comparatively easy (Weber, H. M.: *J. A. M. A.* 113:1541-1546, Oct. 21, 1939).

Uncomplicated diverticulosis of the small intestine does not give rise to any characteristic symptoms. Symptoms referable to the diverticula appear with the occurrence of complications. In 13 of the 122 cases constituting this series, complicating conditions attributable to, or associated with, the diverticula were observed. The known complications of, or associated with, diverticula of the jejunum and ileum are: (1) acute mechanical obstruction, (2) chronic obstruction, (3) inflammatory disturbances, (4) hemorrhage, (5) rupture of diverticulum, (6) foreign bodies, (7) neoplasms, benign or malignant. Eleven cases with unusual and interesting complications are presented in detail.

**Carcinoid Tumors (So-Called) of the Ileum: Report of Thirteen Cases in Which There Was Metastasis.** Malcolm B. Dockerty and Frank S. Ashburn. *Arch. Surg.* 47: 221-246, September 1943.

The author studied the small bowel tumors recorded in the files of the Mayo Clinic from 1906 to 1943. Among a total of some 130, there were 30 carcinoids, and of these 13 showed undoubted evidence of metastasis. The 13 case histories are reported at some length. The youngest patient was 39, the oldest 78, with an average age of 58; 8 were men and 5 women. Evidence of disturbed intestinal function was present in 9 of the cases; in 8 this consisted in symptoms of mild but progressive obstruction. In 6 patients abdominal masses could be palpated. Melena was observed only once, in contrast to other types of small bowel tumor. In 3 cases no gastro-intestinal symptoms were present. Laboratory findings were not characteristic. Roentgen study with barium was not always advisable clinically; in the cases examined acute buckling or kinking of the bowel was a common finding, and this the authors believe is characteristic.

Eleven cases were surgical problems; in 3 only a biopsy was done, because of the extent of the disease, and in another only a biopsy and short-circuiting operation. In 5 a one-stage resection, and in 2 a two-stage resection was done. Eight patients remained alive and well from ten months to fourteen years; 2 lived two and five years, respectively, and 1 died postoperatively. These results are particularly surprising in view of the known presence of metastases.

Pathologically the neoplasms tended to be in the terminal ileum as small, orange, submucosal nodules with minimal ulceration. In half the cases the tumors were multicentric. Involvement of the regional nodes was observed in all 11 instances, and hepatic metastases were present in 5. The microscopic picture was that of a

very low-grade adenocarcinoma. Both this and the power of dissemination shown by these tumors should lead one to consider them malignant.

LEWIS G. JACOBS, M.D.

**Appendiculocolic Fistula. Case Report.** Louis P. River and Billens C. Grading. *Am. J. Surg.* 61: 297-299, August 1943.

The authors present a case of appendiculocolic fistula, presumably due to intracolic rupture of an appendiceal abscess.

A colored soldier, age 24, gave a history of repeated attacks of abdominal cramps. Physical examination was negative except for tenderness on deep pressure over the right lower quadrant. Gastro-intestinal x-ray studies showed continued spasm in the cecal region and the presence of a small residual mottled density at the mesial aspect of the ascending colon slightly above the level of the transverse process of the fifth lumbar vertebra. As the patient continued to complain, the x-ray studies were repeated a month later. Considerable spasm was present in the freely movable cecum, and it was difficult to make it fill well. The small mottled density seen previously appeared to be the wall of the colon, medial to a constantly unfilled area, and near what was thought to be the tip of a well filled, upward and medially directed appendix. At operation, a small, movable retroperitoneal mass was felt at the location of the mottled density. Only after the cecum was well mobilized was the appendix seen. It was then found to extend upward 2.5 cm. from its base, joining a rounded mass, 2.0 cm. wide by 1.5 cm. long, this latter joining the ascending colon 5 cm. above the base of the appendix. The mass was of doughy consistency and its contents were expressed into the colon. From the mesial aspect of this adventitious structure a long, slightly thickened appendix extended downward and laterally toward the tip of the cecum.

**Appendiceal Lithiasis.** Antonio M. Tripodi and Alfred L. Kruger. *Am. J. Surg.* 61: 138-142, July 1943.

A case of appendiceal calculus, diagnosed preoperatively is reported. A 33-year-old soldier complained of a 20-pound weight loss and a poor appetite. Examination revealed only slight tenderness in the right lower quadrant. A scout film, as well as a flat plate of the abdomen with the stomach filled with barium, showed a round, laminated, opaque shadow, measuring about 2 cm. in diameter, in the right lower quadrant, suggesting a gallstone in the terminal ileum. On the six-hour film, it was seen that the calculus was definitely not in the ileum and it appeared as if the appendix, which was filled with barium in its proximal portion, extended into the stone. On fluoroscopy, the cecum, appendix, and calculus were seen to be freely movable, and it was then believed that the shadow represented an appendiceal calculus. Gallbladder studies were normal. Appendectomy was carried out and a stone, 2.5 cm. in diameter, was found in the appendix.

The author points out the importance of distinguishing between fecaliths and appendiceal calculi. The former are of frequent occurrence. The latter are rare. When appendiceal calculus is definitely diagnosed, surgery is indicated, as a superimposed acute inflammatory process with perforation may occur.

**Solitary Neurogenic Sarcoma of the Mesentery. Review of the Literature and Report of a Case.** Morris J. Shapiro and Moris Horwitz. *Am. J. Surg.* 61: 132-135, July 1943.

A solitary neurogenic sarcoma of the mesentery is reported. The patient, a 62-year-old man, was first seen approximately three and a half months before an exploratory laparotomy was performed. During this period he lost 35 pounds in weight and had a septic temperature, up to 103° daily. There was a mass in the abdomen extending about 4 cm. above, below, and to the right of the umbilicus. Preoperative roentgenograms revealed a large irregular accumulation of barium in the right lumbar region, having the appearance of an encapsulated cavity associated with the small intestine through perforation. A diagnosis of a cystic tumor communicating with the intestine was made and confirmed at operation, when a large solitary neurogenic sarcoma was found in the mesentery of the jejunum. Exploration revealed no metastases. The tumor was successfully removed, but the patient died twenty-one months later of metastatic involvement.

**Diagnostic Roentgenology in Gastroenterology for the Year 1941.** Frank J. Rigos and B. R. Kirklin. *Gastroenterology* 1: 669-686, July 1943.

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In the first case roentgen examination revealed an enlarged liver with scattered areas of calcification within the right lobe. The bony framework was within normal limits. Both lung fields showed small areas of partial calcification. No x-ray therapy was given. The patient died eleven days after admission to the hospital. Necropsy showed a tremendously enlarged liver, studded throughout with tumors measuring from 1.5 to 11.0 cm. in diameter, varying from a light blue-green to a dark brown-green color, with soft, necrotic areas. No regional or distant lymph node metastases could be demonstrated, but there was a small circumscribed tumor in a dilated vein in the apex of the left lung. The diagnosis was "primary liver-cell carcinoma (hepatocarcinoma); anemic necrosis with calcification; embolic tumor, left lung." It was thought that the calcification occurred in areas subjected to anemic necrosis due to tumor growth; there was no evidence of a teratoid hepatoma in this case. Of the 82 cases of primary liver-cell carcinoma occurring in children under 16 years of age which have

been reported and found acceptable, only one other case showed calcification without teratoid aspects.

X-ray examination of the other child showed the stomach displaced far to the left and posteriorly by a large upper abdominal mass interpreted as the liver, with enlargement of both right and left lobes. A clinical diagnosis of carcinoma of the liver was made and high-voltage roentgen therapy was given (total dosage not stated). Death occurred approximately thirty-eight days after admission to the hospital. Autopsy revealed a primary liver-cell carcinoma (hepatocarcinoma), extending to the right kidney and adrenal and through the diaphragm to involve the mediastinum. X-ray therapy had not produced any significant necrosis of the cells or evidence of degeneration.

### THE ADRENAL GLANDS

**Cushing's Syndrome in Children. Review of the Literature and Report of a Case.** Jason E. Farber, Francis J. Gustina, and Anthony V. Postoloff. *Am. J. Dis. Child.* 65: 593-603, April 1943.

While it is generally believed that Cushing's syndrome rarely occurs in children, the authors were able to collect from the literature 26 cases of the disease with onset before the age of 16. They review these, presenting the outstanding features in a table, and report an additional case.

A white boy aged 15 years was admitted to the Meyer Memorial Hospital (Buffalo, N. Y.) on April 2, 1941, complaining of generalized weakness and a severe persistent backache. His symptoms began in July 1940, with a rapidly acquired obesity, mild general malaise, and fatigue after moderate exertion. In November 1940 he suffered mild frequency of urination with nocturia. He also had frequent sore throats, blurring of vision, and occasional frontal headaches. In January 1941, edema of the feet was observed on several occasions.

The boy's history of growth, development, and illnesses was not remarkable, although he was considered mentally retarded. On admission he was moderately dyspneic and was unable to sit up because of his extreme general weakness, as well as the pain associated with motion. The obesity was confined to the face, neck, and trunk. The height was 170 cm., weight 62.5 kg. The face was florid, greasy, and hairy, and there were a few small areas of telangiectasia. Examination of the visual fields showed some mild peripheral contraction, more evident in the right eye; examination of the eyes was otherwise normal. The blood pressure was 184/112. The external genitals were large but otherwise normal in appearance. There was considerable tenderness on pressure over the lumbar vertebrae. On the lateral and anterior surfaces of the thighs and flanks, and to a lesser extent on the legs, were many purplish striae. Neurologic examination was non-contributory except for revealing sluggish patellar and Achilles reflexes. Laboratory studies showed a decreased tolerance for sugar, hypoproteinemia, and hypochloremia.

X-ray examination revealed slight enlargement of the heart. The entire osseous system, especially the skull and spine, showed severe osteoporosis. The skull had a ground-glass appearance; the sella turcica was of normal size. All of the lumbar vertebrae showed narrowing of the bodies due to expansion of the nucleus pulposus.

The patient's condition became progressively worse. He became more dyspneic; his face grew more florid and obese; penile erections became impossible. No benefit was derived from roentgen irradiation of the pituitary body. Blood pressure varied from 190 to 156 systolic and from 142 to 112 diastolic. Examination of the eyegrounds on July 21 showed evidence of prolonged papilledema with absence of disk margins and with many surrounding old hemorrhages and exudates and a few areas of retinitis proliferans. The visual fields showed beginning bitemporal hemianopsia.

Retrograde pyelograms strongly suggested the possibility of a tumor in the region of the upper pole of the right kidney, extrinsic to the organ. Perirenal pneumo-roentgenograms outlined a large adrenal tumor. A roentgenogram of the chest at this time showed scattered areas of pulmonary infiltration suggesting metastases. In spite of this, it was deemed advisable to remove the tumor, which proved to be an adrenal cortical carcinoma. Death occurred the day following operation. At autopsy tumor metastases were found in the lungs, kidneys, and veins.

### THE SKELETAL SYSTEM

**Symphalangism, a Familial Malformation.** Paul Freud and Lawrence B. Slobody. *Am. J. Dis. Child.* 65: 550-557, April 1943.

Symphalangism is defined as hereditary aplasia or hypoplasia of the interphalangeal joints and is believed to follow a simple dominant mendelian type of transmission. A family tree which covers four generations is presented. Nine of 10 members of the family were known to have symphalangism. Four of these cases, in a girl of 18 months and her three brothers, are described in detail and illustrated. The family at first glance was thought to be Negro, but one of the progenitors was found to be an American Indian, who married a negress. All previously reported examples have been in the white race. Symphalangism is often accompanied by other congenital malformations, such as syndactyly, brachydactyly, pes planus, and absence of the pectoralis muscles.

There may be complete or partial lack of development of the interphalangeal joint, and any or all of the four extremities may be affected. Usually one person will exhibit various degrees of symphalangism in different fingers. The proximal joints are commonly involved and the distal ones rarely. The thumbs are almost never affected, and the fifth fingers infrequently. When the interphalangeal joint is entirely absent, there is no dividing line between the two phalanges. With slight development of the joint, there are two distinct bones and two bone marrow cavities; motion is impossible. When development has progressed a little further, some bending and stretching become possible. The stiffened parts of the fingers and toes have a column-like appearance, and the covering skin is smooth, with none of the folds normally produced by action of the joints.

The differential diagnosis between ankylosis of the finger joint and symphalangism is simple. Symphalangism is present from birth. Several fingers are affected, the segment is extended, and the proximal joints are usually involved. Ankylosis is acquired; the segment is usually flexed, and the distal joints are involved.

Roentgenograms are presented, demonstrating the

manner in which the various stages of articular differentiation occur during the life of the embryo. The earliest change is a constriction of the phalangeal beam. This progresses until only a central bony bridge remains. This bridging becomes less distinct and then invisible, and finally a normal joint space is formed. The process may cease at any point before complete differentiation, with resulting symphalangism.

**Roentgenologic Aspects of Ewing's Tumor of Bone Marrow.** Paul C. Swenson. *Am. J. Roentgenol.* 50: 343-353, September 1943.

Twenty-six cases of Ewing's tumor, histologically proved and with fairly complete clinical and laboratory data, form the basis of this paper. The pathology and histogenesis of the tumor, as determined from a study of these and 16 additional cases, are the subject of an immediately preceding paper in the same journal (pp. 334-342) by Stout. Swenson merely points out that the histogenesis of the tumor is still disputed. Its cellular composition varies and because of this there are those who consider it a variant of reticulum sarcoma rather than a tumor having its origin "from vascular endothelium."

Of the 26 patients, the youngest was four years of age and the oldest was seventy-nine, the majority of cases falling in the period between ten and thirty years. Eleven patients were females and fifteen males. The initial lesions occurred most frequently in the humerus, ribs, femur, and ilium, in that order. Extra-osseous involvement was almost an invariable finding. Metastasis to the lungs is a common terminal episode; also to the brain and other viscera.

Although the roentgenogram may reveal involvement of only a portion of the shaft of a long bone, pathologic specimens usually show that the disease has extended much further along the center of the bone than was apparent roentgenographically. Therefore, it is well to assume that the entire shaft may be involved. Because of the non-osseous origin of the tumor, only reactive or non-tumor bone is produced. This may be subperiosteal, in which case it is usually described as characteristically deposited in onion skin-like layers, or it may be intracortical. It was the author's experience that bone lysis was usually the predominant finding. Few of the tumors in the series studied resembled each other except that their malignant nature was apparent.

The histopathologic picture of the 26 cases varied. The impression was that the tumor always arises in the marrow. In most of the cases there seemed to be a definite expansion of the cortex. No estimate, of course, can be made of the amount of marrow involvement. Although there will be suggestive roentgenographic and clinical features in these tumors, biopsy will have to be the deciding factor in all.

As suggested above, it should be assumed for the purpose of roentgen therapy that the entire shaft of a long bone is involved. The lesion should be cross-fired from as many angles as necessary, in an attempt to get a maximum dose of about 4,500 r into the tumor. It is believed that a combination of surgery and roentgen therapy, when possible, will probably give the best results.

Numerous roentgenograms are reproduced and details of the 26 cases are tabulated.

CLARENCE E. WEAVER, M.D.

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**Disabling Changes in the Hands Resembling Sclerodactylia Following Myocardial Infarction.** Alf C. Johnson. *Ann. Int. Med.* 19: 433-456, September 1943.

Trophic changes in the hands resembling the scleroderma and sclerodactylia developing in Raynaud's disease were observed in 39 patients suffering from myocardial infarction. These came from a group of 178 cases of myocardial infarction in a series of 375 patients with grossly evident heart disease. No painful disability of the hands of this nature was observed unless myocardial infarction had occurred. The diagnosis of infarction was made on the basis of a typical clinical picture and electrocardiographic studies.

The first symptoms referable to the hands appeared three to sixteen weeks after the occurrence of the myocardial infarction and consisted in pain and stiffness of the fingers. There was uniform, firm bilateral swelling of the hands, and the skin appeared smooth and tight. Color changes, varying from an erythema to cyanosis occurred, and the hands were cold to the touch. The skin, which was at first thin and glossy, later became thickened and dull, as the swelling subsided. Pain and stiffness continued and atrophy of the soft tissues overlying the phalanges resulted in prominence of the metacarpals and tendons. In some cases roentgenograms showed disuse atrophy of bone. Initial shoulder pain occurred in 27 cases, but this the authors do not consider related to the hand changes.

In summarizing the status of the patients when last seen, the author states that all but 4 had atrophy of some degree; all but 2 had some limitation of motion of the fingers; 22 had contracture of the palmar fascia, and 22 had residual shoulder stiffness.

While the incidence of changes in the hands is high in this series—21.8 per cent of 178 patients with myocardial infarction—the author believes that it would be found to be equally high in comparable studies if allowance were made for certain factors. Thus, some patients do not survive the myocardial lesion long enough for the syndrome to develop; mild changes in the hands may be overshadowed by the cardiac symptoms; many cases are classified as rheumatoid or atrophic arthritis; follow-up data in myocardial infarction are not always available.

The disabling changes in the hands associated with myocardial infarction may be mistaken for those of rheumatoid arthritis, but actually the clinical features are distinctive. The changes are limited to the hands and are strikingly uniform, involving the entire hand and not simply the joints, as is so often the case in arthritis. Stiffness rather than pain is the prominent feature in the later stages, and the entire hand is held rigidly with the fingers semiflexed. Ulnar deviation and subcutaneous nodules so characteristic of rheumatoid arthritis do not occur. Contractions of the palmar aponeurosis of various degrees are common in the syndrome and unusual in rheumatoid arthritis. Finally, the syndrome occurs usually after middle life in patients with severe cardiovascular disease and has a tendency to recession, in contrast to rheumatoid arthritis, which begins usually before middle life in patients without cardiovascular disease, and has a strong tendency to progression and extension.

It is suggested that the cause of post-infarction sclerodactylia (which is offered as a convenient and rational name for this syndrome) is anoxia of the tissues of the fingers, produced chiefly by ischemia resulting from re-

flex vasoconstriction of the arteries of the hand induced by cardiac pain, and that the lesser effects of sclerosis of these arteries and the local anoxemia of the fingers which is part of the general anoxemia resulting from myocardial injury may increase the degree of the damaging tissue anoxia.

Four cases are reported in detail, with pertinent photographs, roentgenograms, and electrocardiograms. Data on the remaining cases are presented in tabular form.

In an addendum the author refers to Kehl's report on Dupuytren's contracture as a sequel to coronary artery disease and myocardial infarction (*Ann. Int. Med.* 19: 213, 1943. *Abst. in Radiology* 42: 311, 1944).

STEPHEN N. TAGER, M.D.

## THE GENITO-URINARY TRACT

**Traumatic Rupture of the Kidney.** Payson Adams. *Am. J. Surg.* 61: 316-323, September 1943.

The normal kidney may be ruptured by force exerted either from the front, side, or back, by a blow, fall, or crushing force. Renal injuries may be classified into three main groups: contusions, with or without subcapsular hematoma; fracture, complete or incomplete; and tears of the renal vessels.

Examination of a patient with kidney injury usually demonstrates severe tenderness in the costovertebral angle, side, and upper abdomen; if perinephritic hematoma is present, a mass may be palpated in the region of the kidney. Shock may occur immediately after the injury or may develop several hours later from hemorrhage. Hematuria is present in 90 per cent of the cases, though obviously it is absent when the ureter has been severed or when the renal vessels have been ruptured and the kidney spared from injury, or when the fracture line does not enter the renal pelvis. If blood clots block the ureter, hematuria disappears.

X-ray examination of the abdomen is often disappointing because the renal areas are obscured by intestinal distention, impossible or inadvisable to relieve with enemas, cathartics, or drugs. It is, however, of considerable value in revealing associated injuries, such as skeletal fractures, air under the diaphragm diagnostic of a ruptured viscus, or multiple intestinal fluid levels, suggestive of ileus. Excretory urography is the most valuable single accessory aid in determining the actual extent of renal damage. Retrograde urography is thought to be unnecessary and undesirable except when additional information is essential.

The author stresses early operation, after primary shock from trauma to the nerve plexus about the kidney pedicle is controlled and before secondary shock from hemorrhage occurs. Seven cases of severely ruptured kidney are analyzed.

**Radiopaque Membranous Pyelitis Following Sulfonamide Therapy.** Payson Adams. *J. A. M. A.* 122: 419-423, June 12, 1943.

The author reports two cases in which a calcareous radiopaque membrane formed on the epithelial surfaces of the calices and renal pelvis of a kidney partially or completely blocked by a small ureteral calculus. This occurred shortly after administration of sulfathiazole in one case and sulfadiazine in the other. The membrane and kidney were available for study in one case; in the other only the membrane, which passed spontaneously.

Sulfathiazole and sulfadiazine should not be given indiscriminately to patients known to have associated ureteral stasis, pyelonephritis, and alkaline urine, as in such cases they may cause the rapid formation of a non-soluble, calcareous, radiopaque membrane. Preventive measures are correction of ureteral stasis, maintaining renal drainage, improving renal output, and rendering the urine highly acid.

Early operative removal of such membranes is not indicated, as separation from the pelvis and calices is difficult if not impossible at this time. Later the membranes may separate spontaneously and pass without operation, or at least they may be more easily removed at operation.

DEPARTMENT OF ROENTGENOLOGY  
UNIVERSITY OF MICHIGAN (R. H. M.)

**Perinephric Abscess in Infants and Children. A Study of Twenty-Six Patients Surgically Treated.** Henry Swan. *Am. J. Surg.* 61: 3-10, July 1943.

Twenty-six proved and 6 possible cases of perinephric abscess, all occurring in children under thirteen years of age, are presented. The author classifies the lesions on an etiologic basis as metastatic (secondary to a distant focus), complicated by underlying renal disease, and secondary to trauma to the kidney. In this series, 11 cases were in the first group, 14 in the second, and 1 in the third.

The symptomatology of perinephric abscess in children differs little, if any, from that in adults. The site of the pain is varied and frequently fails to suggest the perinephrium as the site of disease. The type of abscess, whether metastatic, complicated, or traumatic, may usually be diagnosed from the history, an antecedent infection suggesting the metastatic type of lesion, while a history which includes urinary complaints or the finding of albumin or white cells in the urine is indicative of a complicated type of lesion. A "limp," due to irritation of the psoas muscle by the overlying inflammatory process, is a frequent complaint and may give an erroneous impression of hip-joint disease.

Intravenous pyelography should be included in the preoperative study of every patient suspected of having perinephric abscess unless the patient is so ill that the procedure is contraindicated. This will give confirmatory evidence in establishing the diagnosis, will

demonstrate underlying renal abnormalities in those patients with the complicated type of lesion, and will establish the presence and gross functional status of the contralateral kidney.

For metastatic or traumatic perinephric abscess, early incision and drainage constitute the treatment of choice. In abscess complicating urinary disease, therapy must be individualized, consisting in immediate treatment of the perinephric abscess and the subsequent treatment of the underlying urinary tract lesion. Cystoscopy and retrograde pyelography, when the condition of the patient permits, give valuable information on the status of the urinary tract and the treatment indicated.

## COMPLICATIONS

**An Unusual Complication of the Intraspinal Use of Iodized Oil.** Paul C. Bucy and Irving J. Spiegel. *J. A. M. A.* 122: 367-369, June 5, 1943.

The authors point out that, in most of the few reports of permanent undesirable effects following the intraspinal use of iodized oil, the final proof that the effects were directly due to the oil has not passed the most critical analysis without question. They record the case of a 36-year-old man with spondylolisthesis for which the lumbosacral spine had been fused in April 1937. About a year later lipiodol myelography was done because of the development of left sciatica. Fluoroscopy revealed that some of the oil lodged at the level of the eighth dorsal vertebra and remained there permanently. Late in 1941 progressive symptoms of involvement of the spinal cord at that level developed. Almost complete spinal block was found on lumbar puncture in February 1942. At operation, on March 10, 1942, two collections of encysted iodized oil in the subarachnoid space and a very thickened arachnoid membrane were found and removed. Nearly complete recovery followed in a few weeks.

It is concluded that in this case the presence of a pre-existent localized adhesive arachnoiditis caused some of the iodized oil to become trapped at that point. The iodized oil in turn stimulated fibroblastic proliferation in the leptomeninx, thus increasing the arachnoiditis and resulting in dysfunction of the spinal cord.

DEPARTMENT OF ROENTGENOLOGY  
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## RADIOTHERAPY

### NEOPLASMS

**Malignant Tumors of the Middle Ear and the Mastoid Process.** Frederick A. Figi and Bert E. Hempstead. *Arch. Otolaryng.* 37: 149-168, February 1943.

Thirty-eight cases of cancer involving the middle ear and the mastoid process are reported: 25 were intrinsic, originating in the middle ear or mastoid process; 13 were extrinsic, originating in the pinna or in the structures adjacent to it.

The symptoms most commonly complained of are pain, discharge from the ear, ulceration in or about the ear, and decreased hearing on the affected side. The clinical findings vary greatly depending on the origin of the neoplasm, subjective symptoms being out of all proportion to the physical findings. Tumors developing intrinsically may reveal little evidence of their presence

until well advanced. Frequently the external canal is filled with polyps, which are recurrent and may be fairly fibrous. A highly vascular, readily bleeding mass or a granular growth may be present in the canal or the canal may be narrowed by a diffuse thickening or infiltration of its walls. In extrinsic cancer, the clinical findings are likely to be pronounced and in a high percentage of cases a diagnosis of epithelioma can readily be made.

Roentgenograms of the mastoid process should be made in all cases of chronic infection of the ear and in those cases where there is a possibility of cancer. This is particularly true in cases of an intrinsic lesion, since in these the roentgenograms will frequently furnish valuable information. Roentgenographic studies are also essential in cases of extrinsic tumor extending into the external auditory canal or fixed to the mastoid



process. Although roentgenograms at times fail to reveal early involvement of the bone by a neoplasm, they often are of aid in determining the extent of the process if invasion of the bone is present. Among the 25 cases in this series in which the cancerous process arose within the mastoid cavity or middle ear or deep in the external auditory canal, the roentgenograms revealed evidence of pathologic change in the mastoid process in 21. Destruction of bone was evident in 8 cases, cloudiness in 7, sclerosis in 7, and a postoperative defect in 4. Among the cases of extrinsic cancer, roentgenograms were positive in 9; destruction of bone was shown in 6 cases and cloudiness in 5; in 4 cases some cloudiness of the mastoid cavity was present, but destruction of bone could not be discerned.

The authors have found the wide removal of the accessible portion of the neoplasm by means of electrocoagulation—either the coagulating or the cutting current or both—a definite improvement over excision. After thorough surgical removal of the neoplasm, radium points or tubes are placed directly in the operative cavity and a fairly caustic dose is given. If removal of the tumor appears to have been clean, points containing 1 mg. each of radium element encased in platinum usually are employed, from ten to fifteen of these being held in place by means of iodoform gauze, which keeps them well removed from the bone itself. These points remain in the wound for from twenty to thirty hours, a total dose of 300 to 400 mg. hr. being administered. A few days after operation, this treatment is supplemented with radium packs, an additional dose of from 4,000 to 18,000 mg. hr. being given. In cases in which the tumor is found to be highly malignant and the involvement so extensive that complete surgical removal appears impracticable, no attempt at complete surgical exenteration is made; radium points or tubes are immediately implanted directly into the growth, and the wound either is sutured loosely or a gauze pack is inserted to hold the radium in place. Considerable necrosis of bone usually results from electrocoagulation and irradiation, and removal of the resultant sequestrum, after separation, is required.

The authors summarize the results obtained in their series of 38 cases. Twenty patients lived two years or more after treatment, 15 three years or more, 10 seven years or more, 8 eight years or more, 3 more than ten years, and 1 fifteen years. Two patients could not be traced.

**End Results of Treatment of Malignant Lesions of the Nasopharynx.** Gordon B. New and Walter Stevenson. *Arch. Otolaryng.* 38: 205-209, September, 1943.

A follow-up study was made of 271 patients treated prior to 1937 for malignant tumors originating in the nasopharynx. A biopsy revealed evidence of a malignant process except in 37 cases; in these cases the subsequent course of the disease confirmed the clinical diagnosis. Of the 234 histologically proved cases, 184 were squamous-cell carcinoma, 7 adenocarcinoma, and 43 sarcoma. Almost two-thirds of the treated patients were between 30 and 59 years of age. The average age of all the patients treated was 43.3 years.

All cases were treated by irradiation. The radium was introduced into the nasopharynx by means of a lead T applicator. The cross piece of the T, in the form of a trough, carried the radium directly against the tumor. Supplementary external radium or roent-

gen irradiation was employed in every instance. Fractional doses of roentgen rays were used in some cases. The patients returned every six weeks or two months for observation, and further therapy, directed into the nasopharynx or given externally, was carried out as indicated.

Of the patients who had sarcoma, 26.8 per cent were alive five years after treatment; and of patients who had squamous-cell epithelioma, 8.9 per cent were alive. Of the total number of patients who had malignant lesions, 13 per cent were living after five years. Twice as many patients with squamous-cell carcinoma were alive in the group without involvement of the lymph nodes at the time of treatment as in the group with such involvement.

**Lymphoepithelioma of the Nasopharynx. Report of a Case.** A. H. Persky. *Arch. Otolaryng.* 37: 813-818, June 1943.

A case of lymphoepithelioma of the tonsil and nasopharynx is reported.

A woman, aged 52, was admitted to the hospital on July 17, 1940, complaining of a lump on her neck. This was first noticed thirty years before and had become progressively larger, until on admission it was the size of an orange. The growth was always symptomless, freely movable and painless, and moved up and down with swallowing. Examination showed the right tonsil to be greatly hypertrophied, extending beyond the mid-line, upward above the level of the soft palate, and downward along the carotid artery. It was rather firm, and on the mesial surface was a small superficial ulceration. On the right side was a palpable, painless submaxillary lymph node.

On July 24, the right tonsil was removed. The mass was well encapsulated and was enucleated from the fossa readily, leaving no residual tissue. There was no evidence of extension of the growth along the large vessels of the neck, nor were the cervical nodes palpable. The pathologic diagnosis was not conclusive, but the condition was thought to be an early Hodgkin's disease or a lymphoepithelioma.

On June 9, 1941, the patient was again seen, complaining of nasal obstruction and a swelling along the right side of her neck. This swelling was first noticed four months earlier and had become gradually larger. Examination of the throat revealed no evidence of recurrence of the original tumor, but the entire chain of cervical lymph nodes was palpable and enlarged. Each node was discrete, freely movable, and painless. A tentative diagnosis of Hodgkin's disease was made. Before a biopsy could be performed, however, the patient suddenly began to expectorate blood, and the following day she vomited a large quantity of black blood. On examination the bleeding proved to come from a large, soft, well encapsulated mass high in the nasopharynx, well above the level of the soft palate. A biopsy suggested a diagnosis of Schmincke's tumor (lymphoepithelioma).

High-voltage roentgen therapy was given: fourteen daily treatments of 200 r each, directed to alternate sides. The bleeding stopped and the tumor regressed rapidly. On June 29, it was impossible to find any residual evidence of tumor tissue, and locally the condition was considered cured. Death occurred from coronary occlusion about six months after the second admission.

This case presents a number of interesting features—the occurrence of the growth in the tonsil; the belated



appearance of cervical adenopathy (probably metastatic); the tumor in the nasopharynx, which would have been unrecognized if it had not been for the profuse hemorrhages; and the prompt regression of this latter growth after the institution of high-voltage roentgen therapy.

The author discusses the possible correlation of the two pathologic processes—whether the nasopharyngeal growth was merely a recurrence or metastasis of the original tumor in the tonsil or whether there were two malignant growths occurring about a year apart. He seems to favor the latter view.

**X-Ray Treatment of Diseases of the Larynx.** Maurice Lenz. *Ann. Otol., Rhin. & Laryng.* 52: 85-108, March 1943. Also in *Tr. Am. Laryng. A.* 64: 206-237, 1942.

X-ray treatment is employed chiefly in three groups of laryngeal diseases, namely, chronic inflammation, benign tumors, and cancer.

Inflammatory tissue is more radiosensitive than the adjacent normal tissues, and the latter remain practically unaffected by the small doses necessary to inhibit the growth of the former. Benign tumors are less responsive to radiation than inflammations, and some are so radioresistant as to make x-ray therapy impractical. The treatment is more likely to be successful in hemangiomas and papillomas. Carcinoma of the larynx is usually more radioresistant than either of the first two groups. The x-ray dosage which is required to arrest the growth in most of these cases is close to the maximum tolerated by the normal tissues and produces sloughing of the irradiated epidermis and of the laryngeal and pharyngeal mucosa. Unless the dosage has been too intensive, however, healing follows soon after the slough has separated, leaving little or no clinical evidence of radiation damage of the normal tissues.

**Inflammations:** The inflammatory diseases of the larynx in which x-ray treatment has been carried out most often are tuberculosis, blastomycosis, and scleroma. The author quotes numerous authorities on dosage and results in these lesions but does not record any extensive personal experience.

**Benign Tumors:** A case of hemangioma in an infant of 8 months and one of multiple papillomas in a woman of 22 years are recorded. The dosage in the child was 1,000 r to each side of the larynx, 150 r being given daily to alternate fields, with a 5-cm. cone (200 kv., 25 ma., 50 cm. T.S.D., 0.5 mm. Cu + 1.0 mm. Al). Treatment was given from June 9 to June 25, 1941, and eleven months later there was no evidence of disease. In the older patient repeated attempts to remove the papillomas by a biting forceps had failed. Left and right laryngeal fields were exposed daily for 20 treatments of 100 r each (200 kv., 25 ma., 1.0 mm. Cu + 1.0 mm. Al, 50 cm. T.S.D.). The treatments were given in August and September of 1937 and the papillomas disappeared promptly, with no recurrence until 1941, when a single small papilloma appeared on the right vocal cord. Follow-up studies on several similar cases suggest that x-ray treatment of multiple papillomata in adults is worth while. About 200 r to each right and left lateral laryngeal field, as given in the case quoted, is the dosage generally required.

**Cancer:** The greater part of this paper is devoted to laryngeal cancer. In the Radiotherapy Department of the Presbyterian Hospital, New York, from which the communication comes, the technical factors used are 200 kv., 25 ma., 1 to 2 mm. Cu or Thoraeus filter, plus

1 mm. Al, and a 6 × 8 or a 7-cm. circular field over each lateral surface of the larynx. Occasionally smaller or larger fields are used and rarely an anterior or posterior field is added, depending on the location and extent of the disease. Treatment is started with about 50 to 75 r to each side of the larynx. After a few days, depending on the laryngeal reaction, this is raised to 100 or 125 r per field. The treatment is continued for four to seven weeks up to a total of about 3,000 to 3,500 r to each side, depending upon the size of the field and the laryngeal reaction. At the height of the reaction, the epithelium of the irradiated mucosa sloughs off and the defect is covered by a pseudodiphtheritic membrane. The following table shows the results (as of January 1942) in 89 patients treated between 1932 and 1936. An analysis of these cases is included and several are reported in some detail.

Treatment	No. Treated	No. Clinically Free from Cancer, January 1942
X-ray treatment after total laryngectomy	14	4 (9 years)
X-ray treatment after partial laryngectomy	5	3
X-ray treatment only	70	13
Totals	89	20

**Value of Post-Operative Radiotherapy in Carcinoma of the Breast.** R. McWhirter. *Edinburgh M. J.* 50: 193-207, April 1943.

A series of 1,879 cases of carcinoma of the breast is reviewed. The average age of the patients was 55.5 years. In order to evaluate the results of treatment, the cases are grouped according to the method of staging suggested by Doctor Ralston Paterson: In Stage I the growth is confined to breast. In Stage II there are palpable mobile nodes in the axilla. In Stage III the growth has extended beyond the corpus mammae, the skin is invaded or fixed over an area large in relation to the size of the breast, and the tumor is fixed to underlying muscle. Axillary nodes may or may not be palpable, but if present they must be mobile. In Stage IV there are fixation or matting of axillary nodes, indicating extension outside the capsule, complete fixation of tumor to chest wall, and metastases in supraclavicular nodes, in skin wide of the tumor, to the opposite breast, and to distant parts. In this series 30 per cent of the cases were in Stage I, 17 per cent in Stage II, 20 per cent in Stage III, and 21 per cent in Stage IV; 11 per cent were recurrent carcinomas, and 1 per cent were unstaged.

To show the effects produced by postoperative radiotherapy, two groups of patients are compared—those treated by operation alone and those treated by operation and a full course of radiotherapy (not less than 3,500 r in three weeks to the chest wall and to the whole length of the chain of nodes from axilla to supraclavicular region on the affected side). The cases in Stage IV, which could be given palliative treatment only, and the patients who died postoperatively are excluded. The author found that, if a patient remained free from recurrence of the tumor for a period of three years, she was likely to be alive at the end of five years, and the figures in this report are therefore

based on the shorter period. Symptom-free is used in the sense of indicating that the patient was symptom-free for three years, not merely at the end of that period.

Fifty-four per cent of the patients in Stage I who received radical surgery only were symptom-free for three years; 76 per cent of those who received surgery plus radiotherapy were symptom-free for the same length of time; in Stage II, 28 per cent of the patients who received radical surgery and 60 per cent of those who received surgery plus radiotherapy were symptom-free for three years; in Stage III 21 per cent of the patients who received radical surgery and 44 per cent of those who received surgery plus radiotherapy were symptom-free for three years.

**Treatment of Carcinoma of the Cervix at Charity Hospital: Preliminary Report of End Results.** Manuel Garcia and Leon J. Menville. New Orleans M. & S. J. 96: 87-91, September 1943.

A three-year follow-up study of 226 patients with carcinoma of the cervix seen between April 1938 and August 1939 is presented as a preliminary report.

Treatment was by a combination of x-ray and radium irradiation whenever possible. It usually began with external roentgen therapy—1,600 to 2,000 r in air through each of six pelvic ports in a period of 24 days, using 200 kv., 0.5 mm. Cu plus 1.0 mm. Al filtration, and 50 cm. distance. In addition, many patients received 5,000 r or less pervaginally. Radium was applied approximately one month later, when 5,000 to 8,000 mg. hr. were given in four to eight days, about half in the cervical canal and half in the vaginal fornices.

Besides 192 primary cases, the series included 22 recurrences and 12 patients with clinically healed lesions who received prophylactic irradiation, but the results in these small groups are not considered significant. The absolute three-year survival rate for the primary cases (one received no treatment and is therefore omitted) is 37.7 per cent.

For a study of the prognostic significance of various factors, 12 other patients who rejected therapy or discontinued it after one or two visits are omitted, leaving 179 upon which the authors' conclusions are based. Of this number, 174 had squamous-cell carcinoma with a three-year survival rate of 41 per cent, and 5 had adenocarcinoma with a survival rate of 20 per cent. In the 44 septic cases, there was a 29 per cent survival, while in the 135 uninfected cases the survival rate was 43 per cent. Little difference was noted in the age groups. Nine patients had developed carcinoma in the cervical stump and showed 22 per cent survival, whereas the 170 patients having carcinoma in the intact uterus showed 41 per cent survival. Concerning these figures the authors say: The variations in the survival rates recorded are not statistically significant, and we have no evidence to indicate that the type of lesion, the histologic picture, the age of the patient, or the presence of infection definitely influences the outcome of treatment.

As in other series, the anatomic extent of the disease again proved the most reliable standard for prognosis. The survival rates were 81 per cent in Stage I, 60 per cent in Stage II, 33 per cent in Stage III, 6 per cent in Stage IV. The cases having lesions of the stump are not included in these statistics.

Results of series recorded by other authorities are quoted for comparison.

LESTER M. J. FREEDMAN, M.D.

**Hemangioma of the Elbow Successfully Treated with Radium at an Early Age.** Ira I. Kaplan. Am. J. Dis. Child. 65: 785-787, May 1943.

As has been strongly emphasized by many therapists, the earlier in life hemangioma is treated, the more ready the response to irradiation, the better the cure, and the less the ultimate disfigurement. Treatment of birthmarks of this type has sometimes been postponed, however, because of the fear that radiation may cause injuries to growing bones, especially when radium is applied at the area of a joint. It is, indeed, true that growing bone is susceptible to radiation injury, but a study of the cases recorded in the literature discloses that all such injuries were the result of intensive irradiation for a neoplasm or for correction of asymmetry of the limbs. In the treatment of hemangiomas, only mild applications of small doses of radium are employed at long intervals and no intensive, persistent treatment is maintained over any one area. The effect is primarily on the vascular network forming the hemangioma. When properly administered, such radium emanations should be almost totally absorbed in the superficial tissues and should in no way affect the underlying growing bone.

A case is reported in which treatment was applied directly over the elbow joint, opposite the epiphysis. The patient was followed over a period of nine years, from ten weeks to nine years of age. A total of 655 mg. hr. of radium, with platinum filtration, was given over a period of eleven months. The lesion is completely healed; there is no impairment of articular function, nor any evidence of involvement of bone, impairment of epiphyseal growth, or discrepancy in the length of the bones of the two arms.

**Multiple Primary Malignant Lesions. Two Case Reports.** Heinrich L. Wehrbein and John J. Weber. Am. J. Surg. 61: 143-147, July 1943.

Two cases are reported of multiple malignant lesions. One patient had a carcinoma of the stomach and a prostatic carcinoma; both tumors had metastasized. The other patient had a prostatic carcinoma and a rhabdomyosarcoma of the rectum.

The authors call attention to the relative frequency of multiple malignant tumors.

## NON-NEOPLASTIC DISEASES

**Roentgen Treatment of Acute Bursitis of the Shoulder.** John H. Harris. Pennsylvania M. J. 46: 683-684, April 1943.

The author advocates the employment of roentgen therapy in acute bursitis of the shoulder and reports the "most gratifying response" in 40 cases thus treated. Daily treatments are given for three or four days, 250 r in air per treatment. The kilovoltage employed is unimportant providing filtration is adequate. The author has used 200 kv.p. with 0.5 mm. Cu plus 1.0 mm. Al and 120 kv.p. with 5.0 mm. Al, with equally good results. A  $10 \times 10$  cm. area is treated, with centering at the point of maximum tenderness. Care is taken to avoid the lung field.

Within twenty-four to thirty-six hours there is marked relief from pain, and by the end of the third day the severe pain has disappeared. There remains a stiffness which gradually subsides, and most patients are using the arm in a normal manner in a week to ten

days. The calcium is slowly absorbed, and in the cases re-examined it had completely disappeared in three to four months.

**Erythroblastic Anaemia with Review of the Literature.** James M. Flynn. *Brit. J. Radiol.* 16: 157-165, June 1943.

Erythroblastic anemia (Cooley's anemia, von Jaksch's disease) is commonly seen in the children of Mediterranean races. Its occurrence in other races has never been proved. The cause is unknown.

The symptoms are pallor, enlarged spleen, progressive anemia, and icterus. The blood picture shows marked achromia and poikilocytosis. The red cells are resistant to hypotonic salt solution. Normoblasts are characteristically present.

The long bones have a thinned cortex with prominent trabeculae at the ends and increased porosity, some areas presenting a "punched-out" appearance. The skull changes are especially characteristic. There is increased thickness, particularly in the frontal and occipital regions. Striations appear perpendicular to and arising from the thin inner table.

No known treatment is of any avail. Splenectomy is indicated when the spleen is unduly enlarged, but this does not change the course of the disease. Authorities differ as to the value of irradiation. The preponderance of evidence is that it is unsuccessful.

One case is recorded and an excellent review of the literature is presented. Eighty-six references are appended.

SYDNEY J. HAWLEY, M.D.

## EXPERIMENTAL STUDIES

**Effect of X-Rays on Aqueous Solutions of Biologically Active Compounds.** Walter M. Dale. *Brit. J. Radiol.* 16: 171-172, June 1943.

On exposing solutions of crystalline carboxypeptidase of various concentrations to different amounts of roentgen radiation, it was found that dilute solutions could be almost completely inactivated by small doses while concentrated solutions required proportionately much larger doses to produce the same effect. It was also found that the enzyme was not inactivated in the presence of its substrate and that this "protection phenomenon" was exerted by a number of other substances, as nucleic acid and various sugars. Sodium chloride, however, did not protect the enzyme from inactivation. Both the dilution and protection phenomenon held for organic biologically active substances other than enzymes, such as acetylcholine. Both phenomena and their quantitative relations may be understood by assuming that the radiation acts upon the solvent, forming an intermediate product, which then reacts with the solute.

These roentgen findings indicate that the biological effects of radiation are to be explained upon an indirect-action theory rather than a quantum-hit theory. The indirect-action theory accounts not only for the effects in simple solutions but also in complex systems. It explains adequately both the dilution effect and the protection effect and is applicable to conditions of irradiation of living tissue.

According to this theory the effect of x-rays on a given substance will depend on the specific affinity between it and the intermediate product, on the affinity of other substances present at the same time, on their relative concentrations, and on the physiologic action of these substances.

It is possible to correlate these findings on simple systems with some of the observed phenomena in more complex living matter. Thus, younger cells, more especially embryonic cells, and sprouted seeds are more sensitive than older cells and dry seeds, because of their greater water content (the dilution effect). The variation in radiosensitivity of a cell in certain phases may be explained by the operation of both dilution and protection effects, as local conditions in the protoplasm, which is not homogeneous, may permit changes in the activity of certain proteins after irradiation. This will

also explain the graded "non-specific" response to irradiation and the great "specific" sensitivity under certain conditions.

SYDNEY J. HAWLEY, M.D.

**Response of Cells in Vitro to Variations in X-Ray Dosage.** Ilse Lasnitzki. *Brit. J. Radiol.* 16: 137-141, May 1943.

In experiments previously reported (*Brit. J. Radiol.* 16: 61, 1943. *Abst. in Radiology* 41: 526, 1943), doses of radiation ranging from 100 to 1,000 r to tissue cultures from the choroid and sclerotics of 9- to 11-day-old chick embryos produced temporary inhibition of mitosis with some degenerating cells.

In this study, carried out with the same tissue and dosages of 2,500 to 10,000 r (160 kv. constant potential, 1.2 mm. Al filter, 100 r per minute), breakdown of the cells occurred soon after irradiation; the greatest effect appearing at three hours. Cultures in which mitotic activity was reduced before irradiation responded in the same manner.

The author concludes that the time at which the degenerate cells appeared and the absence of mitotic recovery during the period of observation indicate that the degeneration seen after the doses employed in these experiments is due to a breakdown of cells in the resting stage. This is in contrast to the results following exposure to a dose range of 100 to 1,000 r, which indicated an effect on the dividing mechanism.

SYDNEY J. HAWLEY, M.D.

**Some Results of the Photographic Estimation of Stray X Radiation Received by Hospital X-Ray Personnel.** L. H. Clark and D. E. A. Jones. *Brit. J. Radiol.* 16: 166-168, June 1943.

A method of determining the approximate dosage of stray radiation received by members of an x-ray staff, by carrying a dental film in a suitably designed holder, is described. Only a portion of the film is exposed. On the remainder of the film an exposure of known quantity and quality is made for comparison. While the method is not extremely accurate, it is convenient and errors are on the safe side. Two thousand tests in four different hospitals showed that the vast majority of workers were receiving less than 0.25 r per working day.

SYDNEY J. HAWLEY, M.D.

# RADIOLOGY

A MONTHLY JOURNAL DEVOTED TO CLINICAL RADIOLOGY AND ALLIED SCIENCES

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# RADIOLOGY

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## Roentgen Diagnosis of Primary Atypical Pneumonia<sup>1</sup>

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and

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OUR PURPOSE IN presenting this paper is to describe the roentgen manifestations of primary atypical pneumonia of unknown etiology (1-7) and to differentiate it from pulmonary lesions which it simulates. These include acute and chronic infections of bacterial, fungus, and virus etiology, occasionally tuberculosis, atelectasis, passive congestion, and neoplastic and metastatic infiltrations.

The term atypical pneumonia refers to virus diseases of either known etiology, such as influenza A or B and ornithosis (psittacosis), and those of unknown etiology. Roentgenologically these cannot be differentiated one from another, and for the purpose of this discussion they will be considered in the same category.

The material here presented is based on a correlation of the roentgenological, physical, and pathological findings.

### **PATHOLOGY**

In order better to understand the various roentgen findings, a brief review of the pathology of atypical pneumonia seems necessary. As shown in the microscopic sections taken from our one case which

terminated fatally, as well as in those submitted to us by the Army Medical Museum (8), the pathology is that of an interstitial pneumonitis. It corresponds to the descriptions of Longcope (9) and Saphir (10).

Grossly, the hilar lymph nodes are hyperplastic and edematous. The larger bronchi are inflamed. These pathological changes may explain the increased size and density of the hilar shadows seen in the roentgenogram. The walls of the smaller bronchi are thick and rigid and project above the lung surface when seen on cut section. This thickening and rigidity are represented in the roentgenogram by increased pulmonary markings. Although the lung for the most part is air-containing, focal areas of atelectasis or alveolar exudation are seen. These may explain the mottled density demonstrable roentgenographically in the lung parenchyma (Fig. 18).

Microscopically there is a profound infiltration of mononuclear cells, affecting chiefly the bronchial walls, peribronchial structures, and interalveolar septa, as illustrated by the photomicrographs from our case (Figs. 1-5).

Figure 1 shows thickening of the interalveolar septa by an infiltration consisting

<sup>1</sup> Read by title at the Twenty-ninth Annual Meeting of the Radiological Society of North America, Chicago, Ill., Dec. 1-2, 1943.

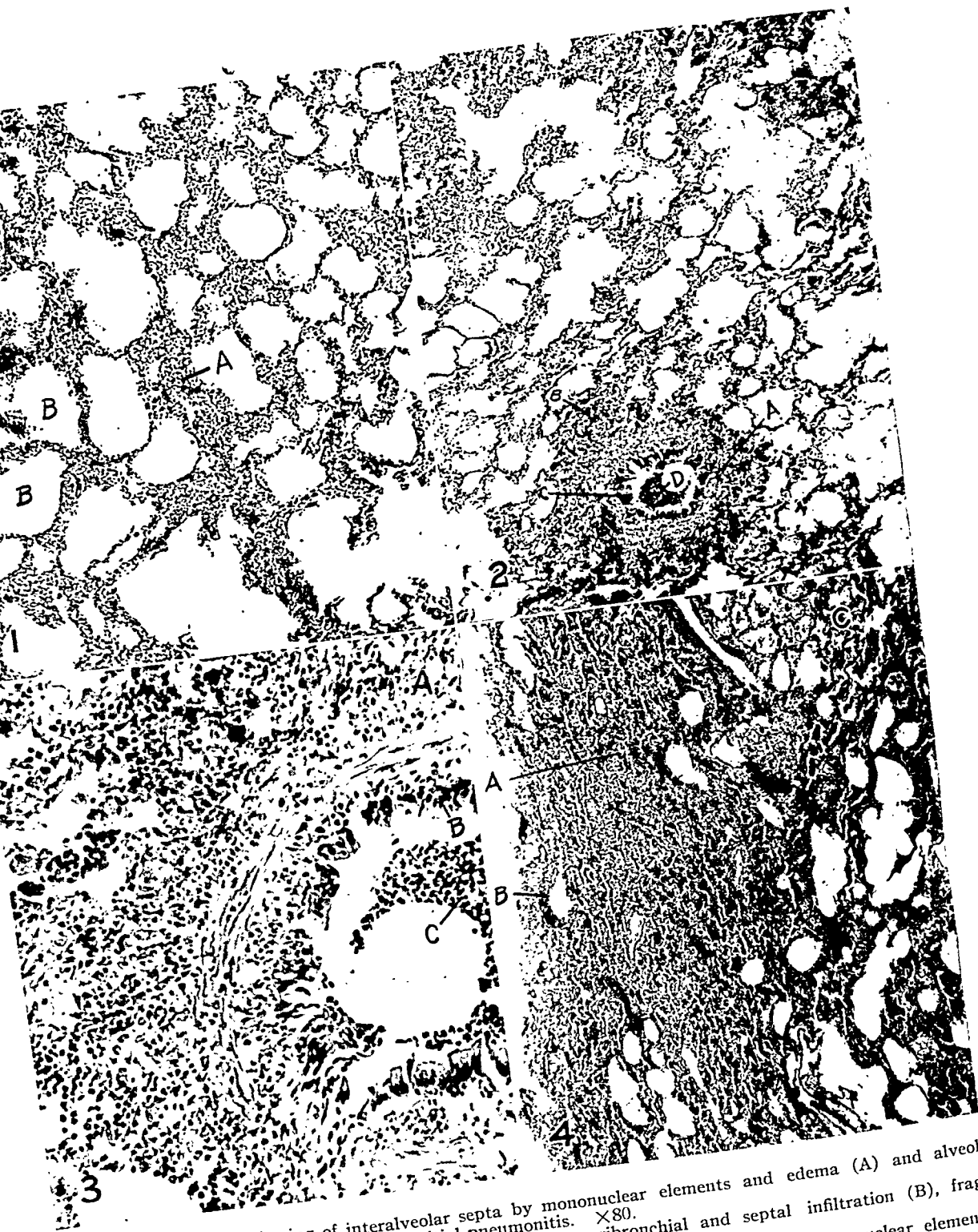


Fig. 1. Showing thickening of interalveolar septa by mononuclear elements and edema (A) and alveoli free of exudate (B), characteristic of interstitial pneumonitis.  $\times 80$ .

Fig. 2. Showing thickening of the bronchial wall (A), peribronchial and septal infiltration (B), fragmentation of the mucosa (C), and cellular exudate (D).  $\times 55$ .

Fig. 3. Showing bronchus under high magnification. Peribronchial infiltration with mononuclear elements (A), disruption of the mucosa (B), and large cellular plug (C).  $\times 220$ .

Fig. 4. Showing atelectasis adjacent to bronchus (A), infiltration of visceral pleura (B), and alveolar exudation (C).  $\times 40$ .

of lymphocytes, histiocytes containing blood pigment, and mononuclear cells (A). The alveoli are free of exudate (B). Because they are still air-containing, the shadow density presumably due to the interalveolar infiltration tends to be soft (Figs. 12-14).

Figure 2 shows a bronchus, the wall of which is edematous and is infiltrated by the same cellular elements (A) as in Figure 1. This infiltrate is present in the peribronchial and adjacent interalveolar septa (B). The bronchial mucosa is fragmented (C). Its epithelium is eroded and the cilia are absent. The lumen is filled by a fibrinous exudate consisting mostly of neutrophils, some histiocytes, and a few monocytes (D). This peribronchial inflammatory reaction as well as the associated congestion may explain the increased density of the truncal markings seen roentgenologically (Figs. 6, 8).

Figure 3 (high-power) shows in more detail the peribronchial infiltrate and atelectasis (A), the thickening of the bronchial walls, the disruption of the mucosa (B), and the cellular plug within the lumen (C).

Figure 4 shows an area of atelectasis adjacent to the bronchus (A). Such areas are fairly common and probably are the result of bronchial occlusion by the cellular exudate (Fig. 3). They may account for or contribute to the soft, downy shadows seen in the periphery of the lung or in the costophrenic angles (Figs. 15, 20). The visceral pleura also shows edema and infiltration (B), appearing on the roentgenogram as slight thickening of the pleura or occasionally a tenting of the diaphragm (Fig. 6). A small patch of alveoli containing a gelatinous exudate is shown (C). In this exudate is found an occasional monocyte but no neutrophils. It is the presence of this exudate that accounts for the patchy density (Fig. 18).

Figure 5 shows an interstitial pneumonitis (A) and a confluent bronchopneumonia containing pneumococci (B). In the latter, the alveoli are filled with an exudate characteristic of the bacterial pneumonias. Such areas of bronchopneumonia also show



Fig. 5. Interstitial pneumonitis (A) and bacterial pneumonia (B).  $\times 55$ .

as a patchy density. Usually they are more dense and more lobular than are those seen in atypical pneumonia. When, however, there is alveolar exudation, irrespective of its nature, aids other than the x-ray are necessary to determine its kind (5, 7).

Lesions similar pathologically to those described above have been observed in influenzal pneumonia (11), ornithosis (psittacosis), American Q fever, and the pneumonias of measles and pertussis (8).

#### SOURCE OF MATERIAL

During the period December 1942 to May 1943, inclusive, about 6,000 patients with an acute epidemic respiratory tract infection were admitted to the Station Hospital, Fort Custer, Mich. Of 500 such patients who were studied in detail, approximately 25 per cent showed roentgen evidence of pulmonary involvement.

#### CRITERIA FOR DIAGNOSIS

It has been said by some that the x-ray findings of atypical pneumonia are char-



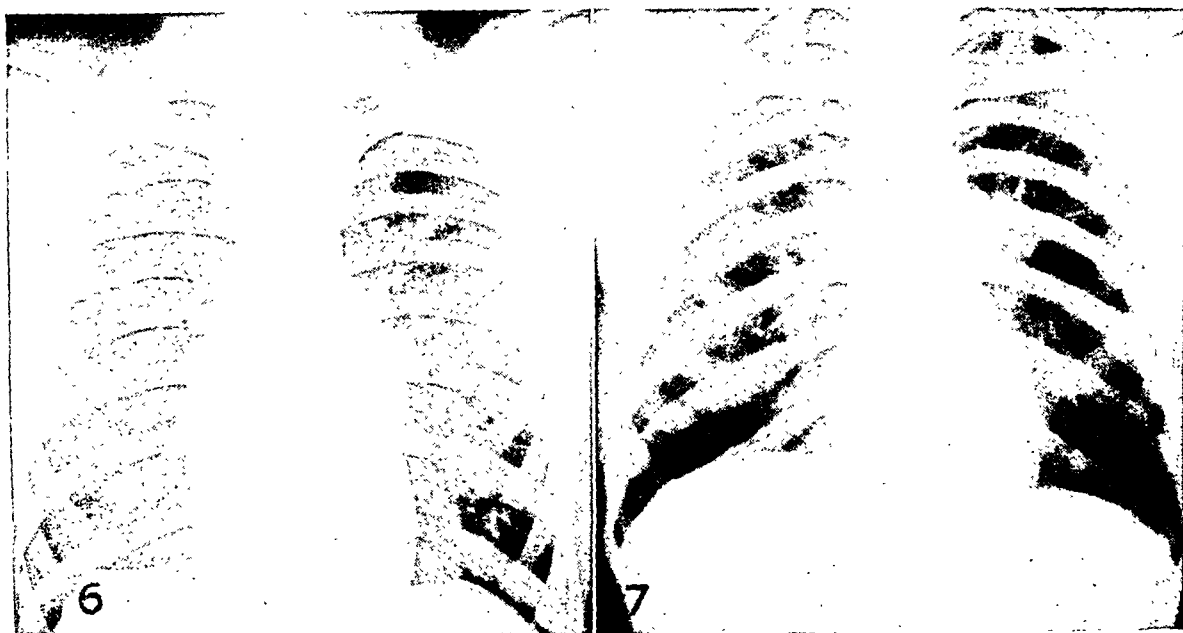


Fig. 6. Bronchitic phase, showing increase in size and density of hilar shadows, prominent pulmonary markings, and a pleural adhesion to the right dome of the diaphragm.

Fig. 7. Boeck's sarcoid, showing enlarged hilar nodes and soft infiltration into the right lung.

acteristic. This statement we feel is not warranted, without qualification. While roentgenologically atypical pneumonia has certain distinguishing features, a diagnosis based solely on the roentgenograms is impossible. Mindful of this, we have felt it necessary to establish certain criteria as a basis for diagnosis. These have reference to the mode of onset, clinical course, physical findings, roentgen findings, white blood count, bacteriologic examination of the sputum, and the response to the sulfonamides.

From our studies of the epidemic of acute respiratory tract infection, we are convinced that the pulmonary lesions are but a local manifestation of a syndrome in which both the upper and lower respiratory tract participate. Just as the disease may predominantly affect the nasopharynx, the larynx, or the trachea, and be correspondingly designated as a nasopharyngitis, laryngitis, or laryngo-tracheitis, so it may affect any part or parts of the pulmonary tract simultaneously or successively. From our physical and x-ray examinations, we find that the manifestations in the lung fall naturally into four phases, *viz.*, the bronchitic, peribronchitic,

alveolar, and broncho-alveolar, depending upon what part of the pulmonary tract is predominantly involved.

#### ROENTGEN DESCRIPTION OF THE PHASES

*Bronchitic Phase* (Fig. 6.): The bronchitic phase is characterized by increased size and density of one or both hilar shadows (12) and prominence of the truncal shadows extending from the hila into the lower lobes. The markings of the smaller bronchi likewise may be demonstrated in the peripheral zone of the lung. These roentgen findings might be explained by the hyperplasia and congestion of the hilar lymph nodes and by the infiltration and congestion in the bronchial and peribronchial tissues (Figs. 2, 3).

The bronchitic phase must be differentiated from acute and chronic bronchitis, of whatever cause, as, for example, chronic sinusitis, tonsillitis, and inhalation of irritating gases. To be considered, also, are passive congestion and enlargement of the hilar nodes of whatever nature.

Certain lesions, as the various types of bronchitis, cannot be differentiated by x-ray studies alone; dependence must be

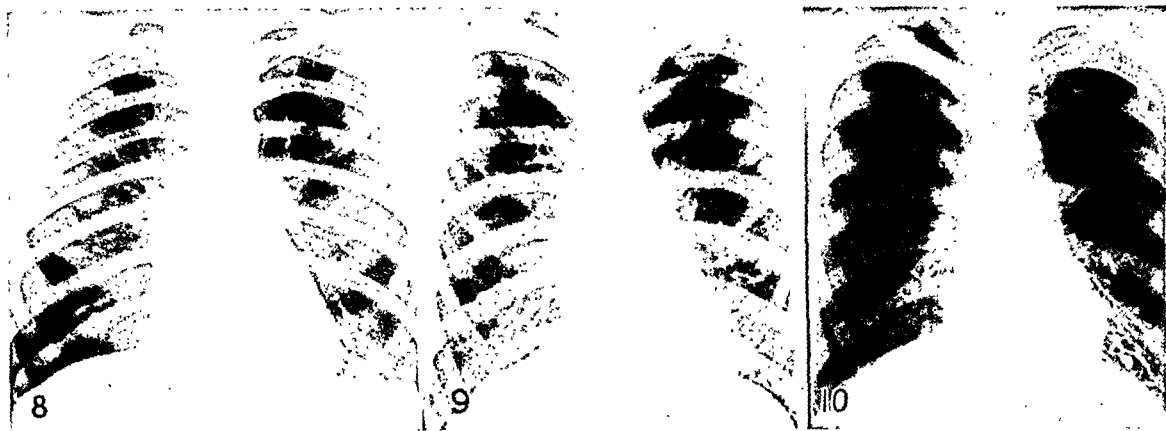


Fig. 8. Peribronchitic phase, showing increased truncal markings in both cardiophrenic areas and evidences of peribronchial infiltration in the left base.

Fig. 9. Bronchiectasis with peribronchial infiltration, simulating atypical pneumonia.

Fig. 10. Bronchiectasis: case shown in Fig. 9 after lipiodol instillation, demonstrating sacculations.

placed, also, on the history and laboratory findings. Some, however, have roentgenologic features which suggest their identity. Among these are passive congestion, lymphoblastomata, Boeck's sarcoid, and the pneumonias of tularemia and measles. In passive congestion the hilar shadows are increased, the pulmonary markings are heavy, occur bilaterally, and generally extend from the hila to the middle zone of the lung. The finding of cardiac disease serves as corroborative evidence. In lymphoblastomata and Boeck's sarcoid (Fig. 7), the hilar enlargement appears more rounded or lobulated. Serial roentgenograms show the enlargement progressing in size. As this occurs, parenchymal miliary infiltrations begin to make their appearance. In tularemia and measles pneumonia, though the hilar adenopathy is the first lesion present, it is soon followed by outspoken evidences of bronchopneumonia.

In other conditions causing hilar enlargement, as tuberculosis and neoplasms, serial roentgenograms whereby progression and regression are shown are of considerable service in differentiation.

*Peribronchitic Phase* (Fig. 8): The peribronchitic phase is characterized by an increase in prominence of the truncal markings as they extend from the hila downward into the cardiophrenic sinuses and lower lobes and outward into the lung

parenchyma. Intimately associated with the increased bronchial and peribronchial shadows, irregular areas of varying opacity and soft mottling are seen. A probable explanation for these shadows may be the presence of peribronchial infiltration, as shown in Figures 2 and 3.

The peribronchitic phase (Fig. 8) is the one most likely to be confused with bronchiectasis, particularly that associated with peribronchial reaction (Fig. 9). The sites and the roentgenological appearances may be similar. While in some instances the presence of bronchiectasis may be suggested by the apparent stability, solidity, and persistence of the lesions as seen on serial roentgenograms, a positive diagnosis can be made only by a bronchogram (Fig. 10). This similarity on the plain roentgenogram may be seen by comparing illustrations of the peribronchitic phase (Fig. 8) and a case of bronchiectasis (Fig. 9).

*Alveolar Phase* (Figs. 11-16): In the alveolar phase, the lesion is variable with respect to location, size, shape, and density (14). It may be located anywhere in the lung, either adjacent to the hilum or out toward the periphery, but seldom does it reach the lung margin. It may occur along the bronchus dorsalis, as seen when roentgenograms are made in the lateral position (15). Usually, however, it is found extending from the hilum outward

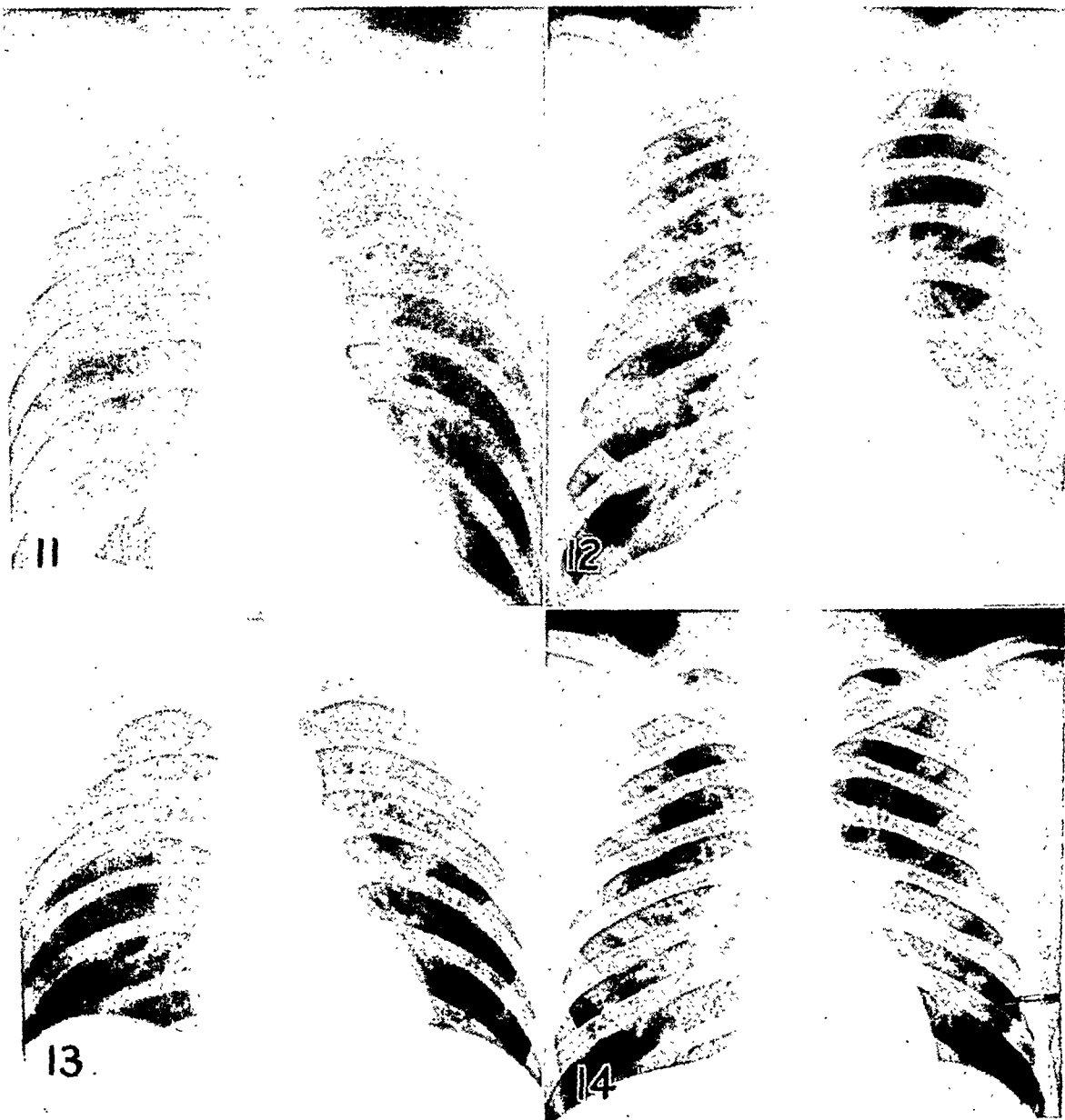


Fig. 11. Alveolar phase: soft, ill-defined, fan-shaped density extending downward from the right hilum.

Fig. 12. Alveolar phase: soft, hazy, cloud-like densities in the lower left and upper right lobes.

Fig. 13. Alveolar phase: soft, fan-shaped density radiating upward from the right hilum, simulating tuberculosis.

Fig. 14. Alveolar phase: soft density in right second anterior interspace, peripherally, simulating tuberculosis.

and downward into the lower lobes (14). In about 20 per cent of the cases it is bilateral (6). The roentgen shadow varies from the size of a millet seed to involvement of the greater part of a lobe (Fig. 11). The smaller lesions are generally rounded, sometimes irregular, well defined or poorly defined, usually dense, and more commonly found in the lower lobes.

The larger lesions are usually triangular, fan- or wedge-shaped, for the most part poorly defined but sometimes well outlined and isolated. Characteristic of all lesions is their soft density. The shadows take on a cloud-like, hazy, downy, ground-glass appearance, fading toward the periphery. Often they are fleeting, migratory, and bizarre. When the pulmonary mark-

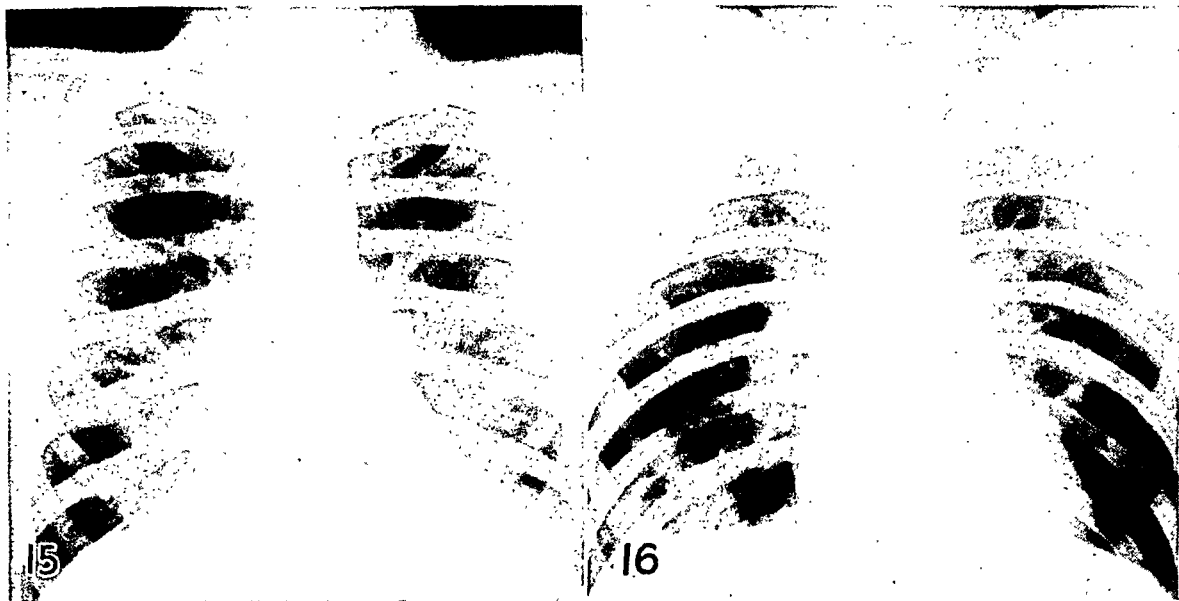


Fig. 15. Alveolar phase: shadow in left base simulating atelectasis.

Fig. 16. Alveolar phase: stage of resolution, resembling a lung abscess.

ings are heavy, they can be seen through this soft parenchymal density.

The roentgen findings described above could be explained pathologically by large areas of atelectasis or alveolar exudation (Fig. 4) or by fairly extensive, heavy but localized areas of interstitial inflammation. It is this picture, distinctive of the alveolar phase, that so often appears unannounced or unaccompanied by symptoms or physical findings, to be disclosed only by chance or on routine roentgen examination. It is to the alveolar phase that reference is made when so often atypical pneumonia is referred to as "x-ray pneumonia."

Because of the extreme variability of its shadows, the alveolar phase must be differentiated from many other pulmonary lesions. These include bacterial pneumonias, especially the lobar type, tuberculosis, atelectasis, pulmonary abscess, encapsulated fluid, neoplasms, and rickettsial and fungus infections. In lesions of the last two types, the differentiation cannot be made roentgenologically, but depends on other aids.

In lobar pneumonia, the shadow is more homogeneous and opaque, usually involves the entire lobe, and frequently is accompanied by evidence of pleuritis. Partial

consolidation or partial resolution of the bacterial lobar pneumonias simulates atypical pneumonia to a marked degree. Differentiation is facilitated by a knowledge of the age of the process.

The exudative form of tuberculosis, appearing as a fan-shaped shadow radiating from the hilum or a solitary parenchymal lesion, must be differentiated from atypical pneumonia. Figures 13 and 14 show the similarity of the alveolar phase to tuberculosis. Roentgen differentiation depends entirely upon serial roentgenograms, as a fleeting, migratory lesion is not characteristic of tuberculosis.

Small areas of atelectasis may be simulated by atypical pneumonia. While these cannot be differentiated except by the history and physical examination, the presence of a horizontal linear disk type of shadow and elevation of the diaphragm on the affected side are suggestive of atelectasis. Figure 15 shows a lesion in the left base which, upon physical examination, was considered an area of atelectasis.

Lung abscess without a fluid level may be simulated by a clearing atypical pneumonia (Fig. 16). Serial x-ray studies show the latter to regress rather rapidly, without a distinct peripheral zone of reaction and

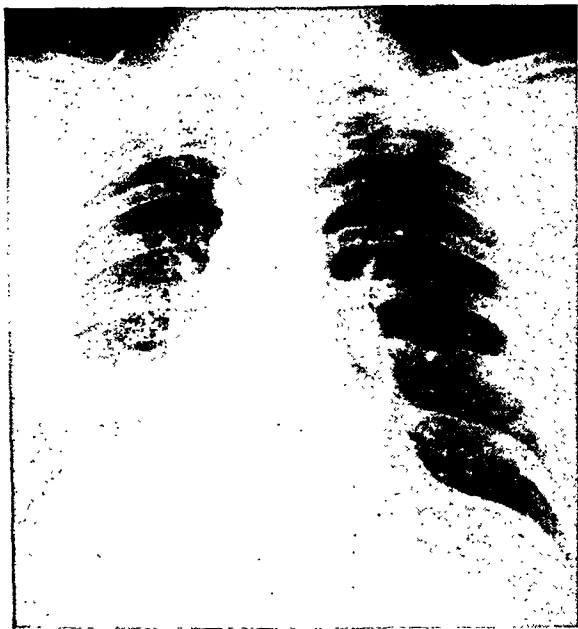


Fig. 17. Atelectasis associated with bronchial neoplasm, simulating atypical pneumonia.

without scarring. In contradistinction, an abscess cavity usually is sharply demarcated, has a dense peripheral zone of reaction, disappears slowly, and often leaves evidence of scarring.

Encapsulated fluid may sometimes be simulated by atypical pneumonia when the latter occurs adjacent to the interlobar fissures. Differentiation can be made by roentgenograms taken in the lateral position. A convex, sharply demarcated, fusiform or wedge-shaped shadow is characteristic of encapsulated fluid. Encapsulated fluid in locations other than the interlobar fissures is differentiated by a well defined, dense, homogeneous shadow.

Neoplasms are seldom confused with atypical pneumonia unless there be a zone of reaction around the lesions, making them irregular and feathery in outline. Where an associated pulmonary atelectasis is a prominent feature, differentiation is difficult (Fig. 17). On serial roentgenograms, these lesions are stable, tend to enlarge, and do not regress.

*Broncho-Alveolar Phase* (Fig. 18): The broncho-alveolar phase is characterized by irregular, soft, patchy, mottled areas of

increased density in the lung parenchyma. These parenchymal densities may exist as small patches or, occasionally, as coarse mottlings in the direction of the pulmonary markings. If the coarse mottlings be widespread, a diffuse type, the so-called "disseminated focal pneumonia" of Scadding (6, 13) is present. The roentgen manifestations of the broncho-alveolar

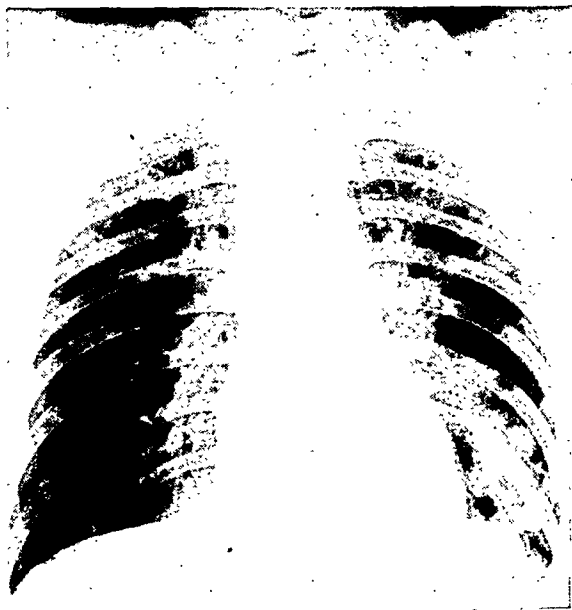


Fig. 18. Broncho-alveolar phase: diffuse mottling in lower left and upper right lobes and right cardio-phrenic area.

phase could be explained pathologically by the small areas of atelectasis and alveolar exudation intermingled with emphysematous areas.

In the broncho-alveolar phase, as in the peribronchitic, which likewise shows dense truncal and hilar markings, the x-ray findings may persist long after the patient is clinically well, in some instances as long as five months.

The broncho-alveolar phase must be differentiated from a variety of conditions, such as bacterial bronchopneumonia, tuberculous bronchopneumonia, the rickettsial and fungus infections, tularemia and measles pneumonias, and occasionally infected bronchiectasis. For the most part, it is difficult if not impossible to make the differentiation on roentgenologic findings alone.

Tuberculous bronchopneumonia (Fig. 19) may simulate this phase of atypical pneumonia so exactly that only serial roentgenograms can be of service. In tuberculous pneumonia, the lesions tend to progress and to become confluent, whereas in atypical pneumonia regression is the rule. Tularemia and measles pneumonias may also simulate this phase of the

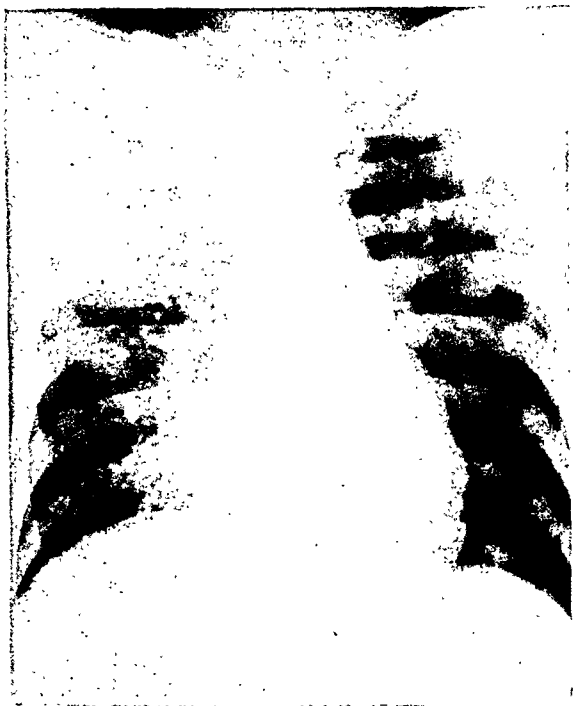


Fig. 19. Tuberculous bronchopneumonia, with tubercle bacilli in sputa, simulating the broncho-alveolar phase.

disease (Fig. 20). These lesions generally are widespread, more dense and sharply demarcated than those of atypical pneumonia. Helpful in differentiation is the tendency for the hilar shadows in tularemia and measles to be larger, denser, and more lobulated. Bronchiectasis with its zone of reaction due to parenchymal infection must be taken into consideration. Its positive differentiation, as has been shown, can be accomplished only by the bronchogram (Fig. 10).

#### COMPLICATIONS

The infrequent occurrence of complications of atypical pneumonia has been considered by others (16, 17). Occasionally



Fig. 20. Measles bronchopneumonia, simulating the broncho-alveolar phase of atypical pneumonia. Soft densities are seen in both cardiophrenic angles and the right costophrenic angle.

we have observed a pleurisy, transitory or adhesive in type, and rarely effusive. The latter, we feel, is usually due to a secondary invader, in which case an empyema may result. Elevation of the diaphragm indicative of pleurisy is often the precursor of pneumonia (18). This pneumonia may be suspected of being bacterial in origin when there is a coalescence of the lesions and the shadow densities become increased.

#### SUMMARY AND CONCLUSION

In an epidemic of some 6,000 cases of acute respiratory tract infection, about 25 per cent showed some phase of atypical pneumonia. The roentgenologic aspects of the disease, which presumably is of virus origin, are presented. It was found that atypical pneumonia might conveniently be divided into four phases, *viz.*, the bronchitic, peribronchitic, alveolar, and broncho-alveolar. Each of these four phases, after correlation with the pathology, has been compared with and differentiated from lesions with which it is most likely to be confounded. It is shown that the x-ray findings in themselves are insufficient evidence upon which to base a

diagnosis and that such aids as physical and laboratory findings must be mustered into service.

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#### BIBLIOGRAPHY

1. BOWEN, A.: Acute Influenza Pneumonitis. *Am. J. Roentgenol.* 34: 168-174, August 1935.
2. ALLEN, W. H.: Acute Pneumonitis. *Ann. Int. Med.* 10: 441-446, October 1936.
3. Official Statement: Primary Atypical Pneumonia, Etiology Unknown. *War Med.* 2: 330-333, March 1942.
4. REIMANN, H. A., AND HAVENS, W. P.: An Epidemic Disease of the Respiratory Tract. *Arch. Int. Med.* 65: 138-150, January 1940.
5. FRANCIS, T., JR.: Personal communication.
6. FINLAND, M., AND DINGLE, J. H.: Medical Progress: Virus Pneumonias. I. Pneumonias Associated with Known Non-Bacterial Agents: Influenza, Psittacosis, and Q Fever. *New England J. Med.* 227: 342-350, Aug. 27, 1942.
7. DINGLE, J. H., AND FINLAND, M.: II. Primary Atypical Pneumonias of Unknown Etiology. *Ibid.* 227: 378-385, Sept. 3, 1942.
8. MACLEOD, COLIN M.: Primary Atypical Pneumonia. *M. Clin. North America* 27: 670-686, May 1943.
9. Army Med. Museum, Major Alfred Golden, January 1943.
10. LONGCOPE, W. T.: Pneumonitis or Virus Pneumonia. *Practitioner* 148: 1-8, January 1942.
11. SAPHIR, OTTO: Pathological Changes in So-Called Atypical Pneumonia, *Radiology* 40: 339-343, April 1943.
12. MACCULLUM, WILLIAM: Monograph No. 10, Rockefeller Institute for Medical Research.
13. KORNBLUM, K., AND REIMANN, H. A.: Roentgenological Aspects of an Epidemic of Acute Respiratory Tract Infection. *Am. J. Roentgenol.* 44: 333-344, September 1940.
14. SCADDING, J. G.: Disseminated Focal Pneumonia, *Brit. M. J.* 2: 956-959, Nov. 13, 1937.
15. SMILEY, D. F., SHOWACRE, E. C., LEE, W. F., AND FERRIS, H. W.: Acute Interstitial Pneumonitis: A New Disease Entity. *J. A. M. A.* 112: 1901-1904, May 13, 1939.
16. CURTZWILER, F. C., AND MOORE, B. E.: Primary Atypical Pneumonia of Unknown Etiology. *Radiology* 40: 347-350 April 1943.
17. KNEELAND, Y., JR., AND SMETANA, H. F.: Current Bronchopneumonia of Unusual Character and Undetermined Etiology. *Bull. Johns Hopkins Hosp.* 67: 229-267, October 1940.
18. DINGLE, J. H., ET AL: Primary Atypical Pneumonia, Etiology Unknown. *War Med.* 3: 223-248, March 1943.
19. MCCARTHY, PAUL V.: Primary Atypical Pneumonia of Unknown Etiology. *Radiology* 40: 344-346, April 1943.



# A Comparative Roentgen Study of Primary Atypical and Bacterial Pneumonia<sup>1</sup>

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NUMEROUS articles have appeared in the literature concerning the bacteriologic and clinical aspects of primary atypical pneumonia, and sporadic attempts have been made to establish roentgenologic criteria for its differentiation from bacterial pneumonia. As Rigler (1) put it, "in the case of acute lung conditions the roentgenogram presents an *autopsia in vivo*, requiring only adequate and intelligent interpretation to make it the most valuable adjunct in the diagnosis and study of pneumonia."

Bowen (2), in 1935, was one of the first to describe the clinical syndrome now designated as "primary atypical pneumonia," which he called "acute influenza pneumonitis." His description of the characteristic roentgen appearances of this syndrome has remained fairly constant throughout the literature. The roentgen shadow is usually described as extending outward from the hilum well into the parenchyma, occasionally reaching the periphery, presenting the appearance of a confluent mottled fan-shaped or rounded area, usually of homogeneous density in the central portion, with the borders fading into the normal lung.

In 1940, Kornblum and Reimann (3) called attention to the "great variability in the type of lesion produced." One of the characteristic lesions they describe as "a fairly well localized area of increased density situated in various portions of the lung but occurring predominantly in the lower lobes. The areas while variable in size were never very large, thus differing from the consolidations encountered in lobar pneumonia. Although the inflammatory reaction was localized, it was not

sharply defined, the opacity tending to merge imperceptibly with the surrounding pulmonary tissues. The areas of involvement varied considerably in density. Again, they were never as dense as the consolidations of lobar pneumonia."

Dingle and Finland (4) suggested similar characteristic findings for the roentgen diagnosis of primary atypical pneumonia, including an increase in size of one or both hilar shadows, followed by an infiltration, extending outward from the hilum toward the periphery of the lung fields, often in the shape of a fan or wedge, fading out gradually into the normal lung parenchyma. The density was described as usually soft, either mottled or homogeneous, more dense near the hilum, but rarely so dense and circumscribed as that in pneumococcal pneumonia and seldom occupying more than a portion of the lobe.

In January 1943, Seeds and Mazer (5), on the basis of 221 cases, established criteria for the roentgen diagnosis of primary atypical pneumonia, which they considered characteristic and fairly constant for the syndrome. They employed such phrases as "cotton-wool appearance of multiple areas of partial or semiconsolidation;" "radial progression;" "occasionally . . . filling approximately a whole lobe to simulate lobar pneumonia but, so far as we have seen, always managing to present a striated infiltrative type background rather than a pure homogeneity;" "development of an appearance of 'wire-grass' infiltration or 'pseudofibrosis'."

In an exhaustive study of primary atypical pneumonia at an army camp, Dingle *et al.* (6) also found the roentgen appearances of the lesions to be "rather characteristic." Their description included an increase in size of the hilar shadow, unilaterally or bilaterally, extending toward the periphery of the pulmonary field in a

<sup>1</sup> Read by title at the Twenty-ninth Annual Meeting of the Radiological Society of North America, Chicago, Ill., Dec. 1-2, 1943. Received for publication in October 1943.



wedge or fan shape, usually fading into the normal parenchyma of the lung before the periphery was reached. They found that one or the other cardiophrenic angle was a common site for the lesion. The infiltration is described as soft and either patchy or homogeneous in character, rarely of sufficient density to resemble a pneumococcal pneumonia.

During the course of twelve months, from August 1942 through July 1943, 2,062 cases of pneumonia were seen at the Regional Station Hospital in Sioux Falls, S. D.; 950 were bacterial pneumonias and 1,112 were primary atypical pneumonias. From a review of these cases, we have come to the conclusion that any attempt to determine the probable etiology of a case of pneumonia from the roentgenogram *alone* is an extremely inaccurate procedure. Cases of primary atypical pneumonia may present a roentgen appearance indistinguishable from that of pneumococcal or other bacterial pneumonias, especially the early and/or resolving stages of the latter. Contrary to most of the descriptions in the literature, we have seen many cases of atypical pneumonia which did not originate in the hilar regions and extend outward, but occurred as circumscribed foci in the periphery of the lung field. We have also seen primary atypical pneumonias occurring in the upper lobes, with roentgen findings simulating those of tuberculosis, as mentioned by Moore and his associates (7).

From the vast amount of clinical material available, we have selected 19 cases which demonstrate the variations of roentgen shadows in both bacterial and primary atypical pneumonia. Careful attention was paid to the clinical symptomatology and laboratory findings in each case. *Only* those cases of pneumococcal pneumonia in which a definite pneumococcus of known virulence was isolated from the sputum were included in this study. The cases selected from the primary atypical pneumonia group conformed to clinical criteria described in previous publications, with a consideration of such factors as a

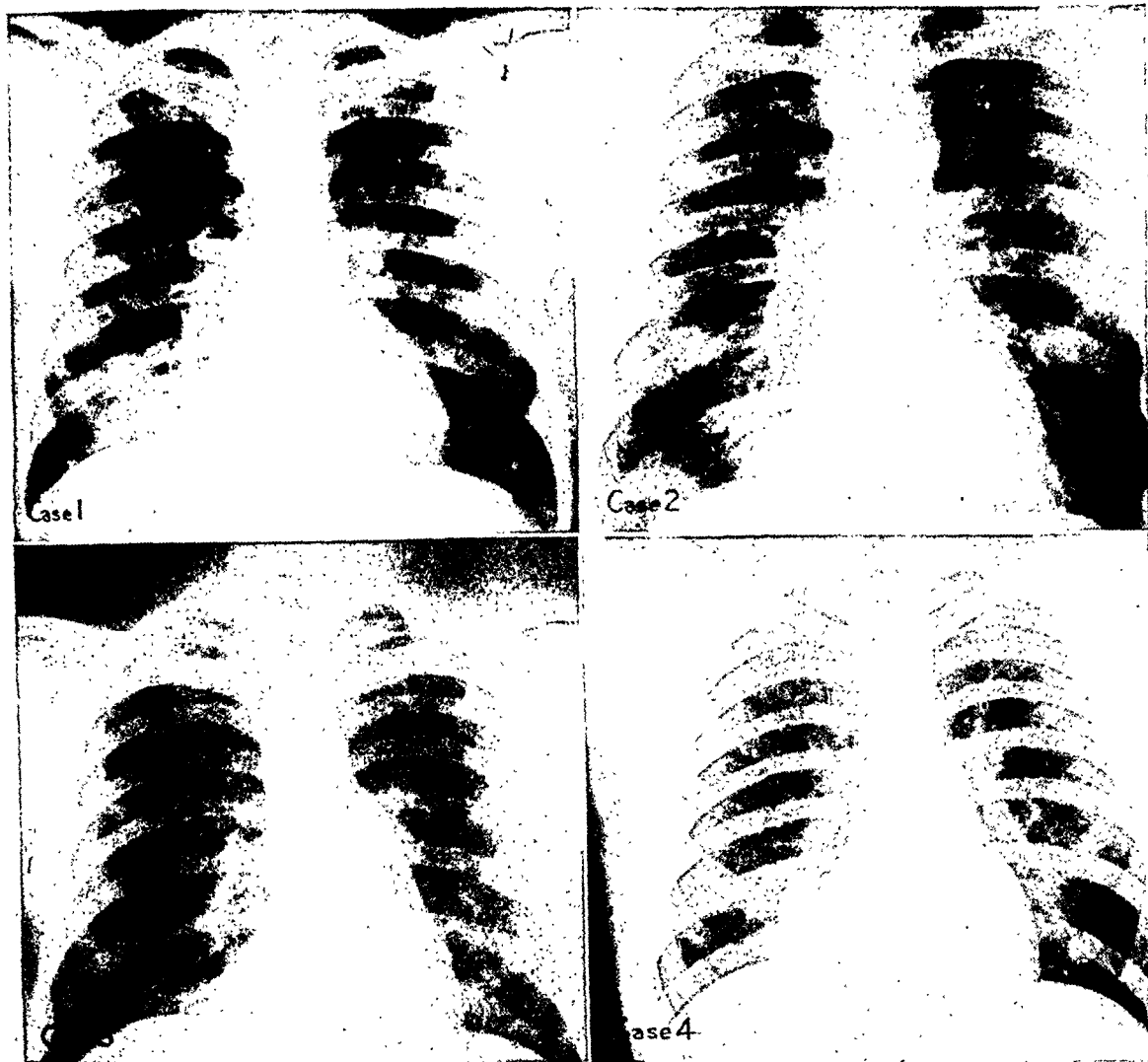
gradual onset of symptoms, absence of pleural pain, presence of organisms in the sputum, a relatively low blood count, and absence of other complications. Any case which did not conform rigidly to these criteria was *excluded* from the study.

#### CASE PRESENTATIONS

CASE 1: Pvt. M. G. L., aged 19, was admitted to the station hospital on May 6, 1943, with a dry hacking cough, fever, and chilly sensations. Suppressed breath sounds and fine crepitant râles were heard over the right lower lobe posteriorly. The temperature was 100.4° F., pulse 80, and respirations 24 per minute. The white blood count was 5,850, with 70 per cent polymorphonuclear leukocytes. No pneumococci were found in the sputum. Roentgen study of the chest revealed a fairly homogeneous increased density in the right cardiophrenic angle consistent with a pneumonia. A diagnosis of primary atypical pneumonia was made. Following a rise to 102° F. several hours after admission, the temperature fell to normal by lysis in seven days. A roentgenogram taken nine days after admission showed some extension into the right middle and right lower lobes. At this time the patient was afebrile and clinically well. Subsequent roentgen studies showed progressive resolution of the lesion.

CASE 2: Pvt. H. C. C., aged 36, was admitted to the station hospital on April 24, 1943, with a dry hacking cough of three days' duration, a sore throat, malaise, and nasal congestion. Clusters of fine crepitant râles were heard at the right base. The temperature was 102.2° F., pulse 110, and respirations 24 per minute. The white blood count was 10,800, with 76 per cent polymorphonuclear leukocytes. No pneumococci were found in the sputum. Roentgen study of the chest revealed an increased density in the right cardiophrenic angle consistent with a pneumonia. A diagnosis of primary atypical pneumonia was made. The temperature gradually dropped to normal in four days with no specific therapy. A roentgenogram taken on May 7, 1943, showed complete resolution of the pneumonia.

CASE 3: Pvt. R. C. W., aged 18, was admitted to the station hospital on May 2, 1943, with a severe hacking cough and sharp pain in the right chest, shaking chills, and fever. On physical examination dullness was elicited over the lower half of the right chest, with suppressed breath sounds and many crepitant râles. The temperature was 102.6° F., pulse 112, and respirations 24 per minute. The white blood count was 19,200, with 88 per cent polymorphonuclear leukocytes. A pneumococcus, type II, was recovered from the sputum. Roentgen study of the chest revealed an increased density in the right cardiophrenic angle. A diagnosis of bacterial pneumonia, type II, was made. The patient made an uneventful recovery on sulfadiazine therapy.



Figs. 1-4. Cases 1 and 2. Primary atypical pneumonia. Cases 3 and 4. Pneumococcic pneumonia.

CASE 4: Pvt. P. L. S., aged 22, was admitted to the station hospital on Feb. 12, 1943, complaining of sudden shaking chills, fever, and pain in the right upper chest. A dry hacking cough had persisted for several days previously. Soon after the onset of the chills and fever, the patient had expectorated some blood-streaked sputum. Dullness and fine moist râles were heard at the right base. The temperature was 102.6° F., pulse 98, and respirations 24 per minute. A pneumococcus, type VII, was recovered from the sputum. The white blood count was 22,100, with 91 per cent polymorphonuclear leukocytes. Roentgen study of the chest revealed a homogeneous increased density in the right cardiophrenic angle. A diagnosis of bacterial pneumonia, type VII, was made. This patient made an uneventful recovery on sulfadiazine therapy.

The pneumonic processes in the four cases just described were confined to the

right cardiophrenic angle (Figs. 1-4). The first and second cases were primary atypical pneumonias, while the third and fourth were pneumococcic pneumonias. A careful roentgenologic appraisal of these four cases reveals no distinguishing features in the location, density, or structural pattern of the lesions which would aid the observer in differentiating the two primary atypical pneumonias from the two pneumococcic pneumonias.

CASE 5: Pvt. P. A. Z., aged 22, was admitted to the station hospital on April 27, 1943, with a wracking cough, chills, fever, and a sharp pain in the left portion of the chest. Dullness, suppressed breath sounds, and fine moist râles were heard over the left lower lobe area. The temperature was 103.2° F.,

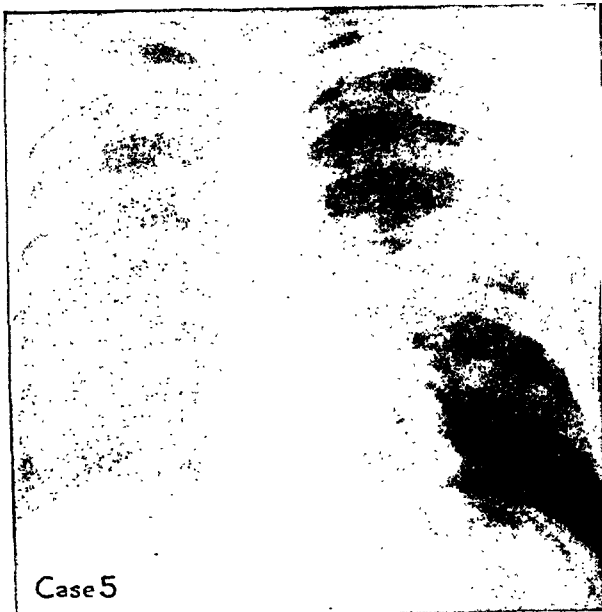


Fig. 5. Pneumococcal pneumonia.

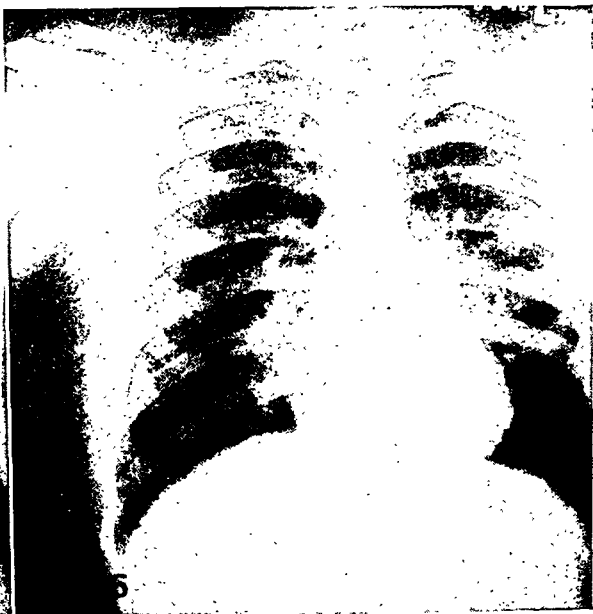


Fig. 6. Primary atypical pneumonia.

pulse 100, and respirations 36 per minute. The white blood count was 21,950, with 94 per cent polymorphonuclear leukocytes. A pneumococcus, type II, was recovered from the sputum. Roentgen study of the chest revealed a mottled increased density in the left hilum which extended out into the parenchyma in a fan-shaped manner. A diagnosis of bacterial pneumonia, type II, was made, sulfadiazine therapy was instituted, and an uneventful recovery followed.

CASE 6: Pvt. J. S., aged 19, was admitted to the station hospital on May 6, 1943, with a sore throat, hacking cough, nasal congestion, fever, and generalized aches and pains. Physical examination of the chest was entirely negative. The temperature was 101° F., pulse 100, and respirations 28 per minute. The white blood count was 8,300, with 65 per cent polymorphonuclear leukocytes. Roentgen study of the chest revealed a fairly compact homogeneous density in the left hilum, consistent with a pneumonia. No pneumococci were found in the sputum. A diagnosis of primary atypical pneumonia was made. Follow-up roentgen study on May 19, 1943, showed a complete resolution of the pneumonia.

Shadows which originate in the hilum and extend into the periphery in a wedge-like or fan-shaped outline have been considered the "classical" roentgen picture of primary atypical pneumonia (2, 4, 6). This has not been our experience. Bacterial pneumonias frequently fan out from the hilum in a similar manner. Roentgen study of Case 5, a type II pneumococcal pneumonia (Fig. 5), revealed a mottled

density radiating outward from the left hilum. Interpretation of this film without a knowledge of the clinical history would lead to an erroneous diagnosis of primary atypical pneumonia. Case 6, a primary atypical pneumonia in the left hilum, is presented for contrast. The roentgenogram of this case (Fig. 6) reveals a fairly homogeneous density localized to the left hilum, with slight fanning out into the periphery. A comparison of the two cases shows that the primary atypical pneumonia has a denser shadow than the bacterial pneumonia, and the bacterial pneumonia fans out, while the primary atypical pneumonia is more localized.

CASE 7: Pvt. R. M. G., aged 21, was admitted to the station hospital on April 14, 1943, with shaking chills, fever, nausea, vomiting, and a sharp pain in the left chest. Physical examination revealed dullness, diminished breath sounds, and some fine moist râles over the left lower lobe. The temperature was 101.2° F., pulse 112, and respirations 24 per minute. The white blood count was 15,400, with 84 per cent polymorphonuclear leukocytes. A pneumococcus, type II, was recovered from the sputum. Roentgen study of the chest revealed a spherical, fairly homogeneous increased density in the left lower lobe partially obscured by the cardiac shadow. A diagnosis of pneumococcal pneumonia, type II, was made. Recovery on sulfadiazine therapy was uneventful.

Roentgen study of this case (Fig. 7)

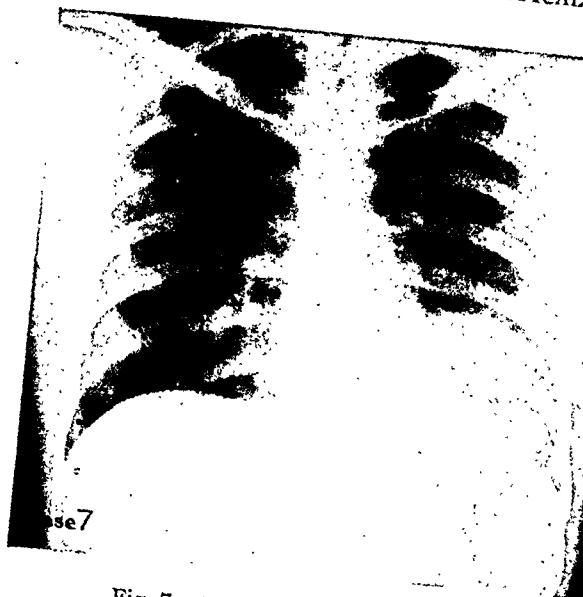


Fig. 7. Pneumococcal pneumonia.

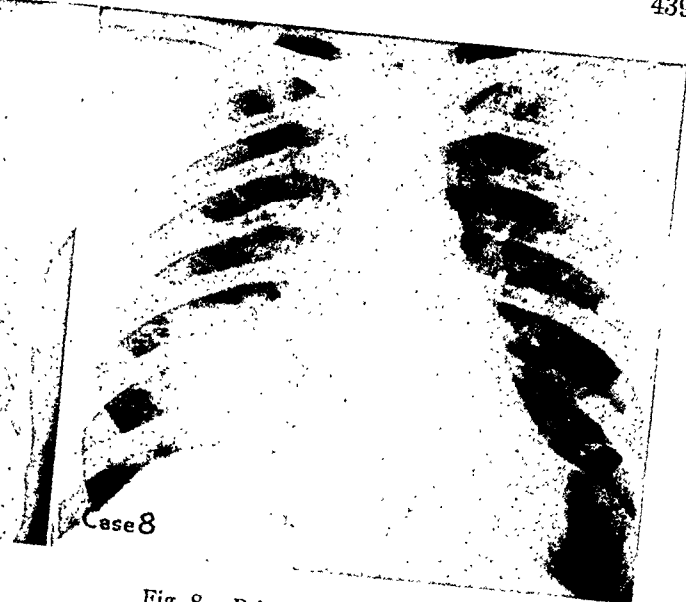


Fig. 8. Primary atypical pneumonia.

showed a homogeneous, spherical density in the left lower lobe, partially obscured by the cardiac shadow. The periphery of the lesion has a feathered appearance and merges imperceptibly with the surrounding pulmonary parenchyma. These roentgen characteristics would suggest primary atypical pneumonia, but the clinical picture is definitely that of a pneumococcal pneumonia, type II.

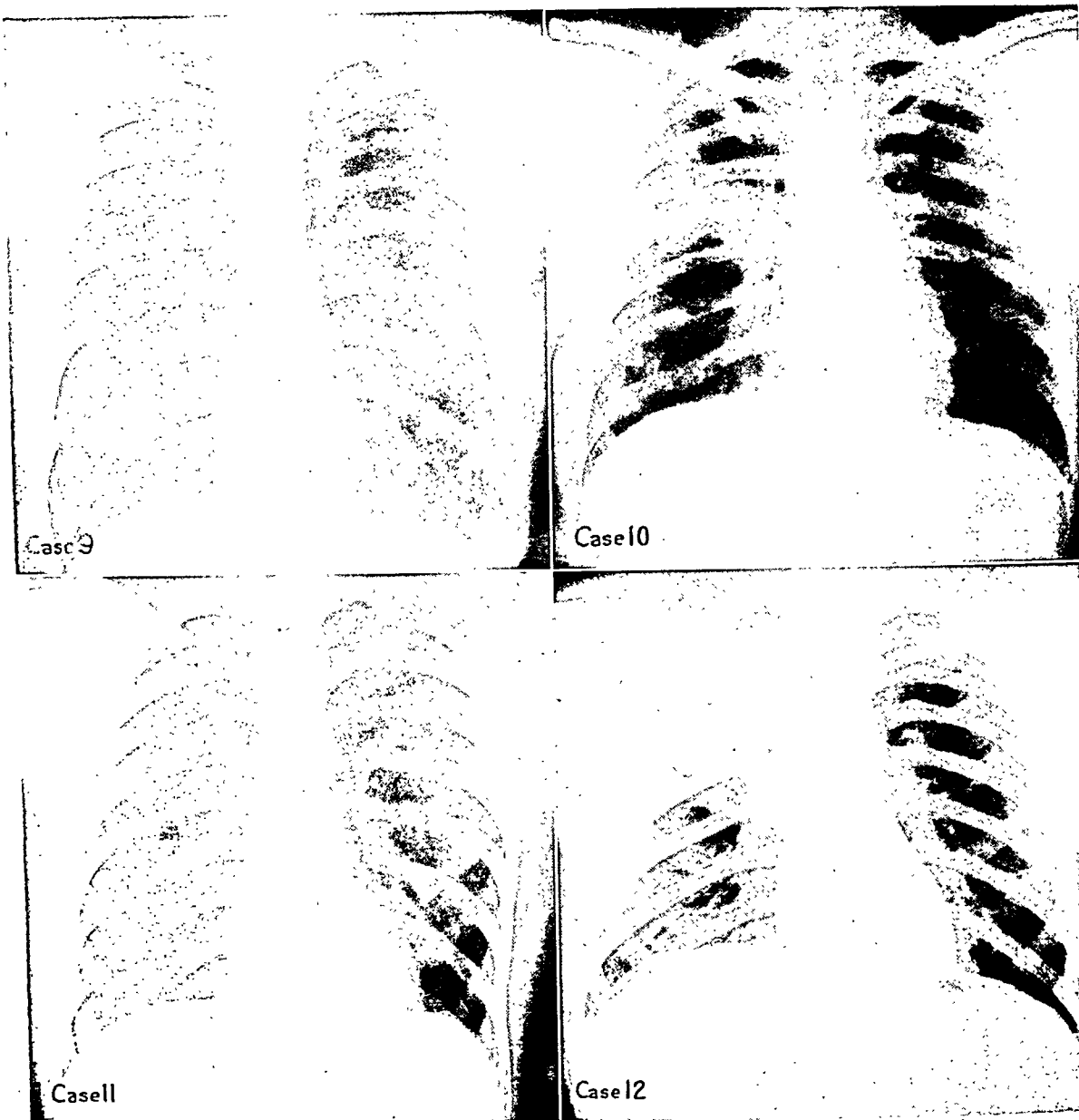
CASE 8: Pvt. G. F. G., aged 29, was admitted to the station hospital on March 7, 1943, with a history of a persistent hacking cough for one month, malaise and generalized aches and pains for several days. Many coarse, moist râles and bronchovesicular breath sounds were heard over the left lower lobe. The temperature was  $103.8^{\circ}\text{F}$ ., pulse 100, and respirations 20 per minute. The white blood count was 11,400. No pneumococci were recovered from the sputum. Roentgen study of the chest revealed a fairly homogeneous spherical area of increased density in the region of the right cardiophrenic angle consistent with a pneumonia. The temperature fell to normal by lysis in three days, and the patient made an uneventful recovery. Three doses of sulfadiazine were administered during the first twenty-four hours of hospitalization, but the drug was discontinued as soon as a diagnosis of primary atypical pneumonia was made.

Some observers contend that primary atypical pneumonia does not produce a roentgen shadow as densely homogeneous as that of a bacterial pneumonia, but shows, usually, a striated type of lesion.

This case (Fig. 8) is one of primary atypical pneumonia with a dense and fairly homogeneous spherical area of consolidation in the right cardiophrenic angle, which could easily be confused with that of a pneumococcal pneumonia.

CASE 9: Pvt. B. T., aged 32, was admitted to the station hospital on Dec. 23, 1942, complaining of a hacking cough and headache for three days and fever on the day of admission. Some crepitant râles were audible at the right base. The temperature was  $102.8^{\circ}\text{F}$ ., pulse 90, and respirations 20 per minute. The white blood count was 10,300. No pneumococci were found in the sputum. Roentgen study of the chest revealed an oval, homogeneous area of increased density in the region of the right lower lobe. A diagnosis of primary atypical pneumonia was made. The patient's temperature fell to normal in four days and recovery was uneventful, with no specific therapy.

Roentgen study of this case (Fig. 9) reveals an oval area of density which might be confused with a pulmonary neoplasm, a lung abscess, or a parasitic cyst. The clinical course and subsequent complete resolution of the lesion established the diagnosis of primary atypical pneumonia. In our experience here, primary atypical pneumonias cast extremely bizarre roentgen shadows with such frequency that any attempt to establish definite or constant roentgen characteristics for this syndrome will lead to a high percentage of diagnostic error.



Figs. 9-12. Cases 9 and 12. Primary atypical pneumonia. Cases 10 and 11. Pneumococcal pneumonia.

**CASE 10:** Pvt. C. C. S., aged 38, was admitted to the station hospital on Feb. 18, 1943, with a hacking cough of several days' duration, sudden pain in the right chest, a shaking chill, and the expectoration of some rusty sputum. On physical examination bronchial breathing and post-tussic râles were heard over the upper half of the right chest anteriorly. The temperature was 103.6° F., pulse 110, and respirations 24 per minute. The white blood count was 19,200, with 91 per cent polymorphonuclear leukocytes. A pneumococcus, type II, was recovered from the sputum. Roentgen study of the chest revealed a mottled increased density in the right hilum with extension into the lower portion of

the right upper lobe, consistent with a pneumonia. The patient made an uneventful recovery on sulfadiazine therapy.

**CASE 11:** Sgt. J. D. S., aged 23, was admitted to the station hospital on Jan. 20, 1943, complaining of sharp pain in the right chest and a shaking chill which lasted for one hour the night before admission. A dry hacking cough preceded the acute onset by three weeks. Frank bronchial breath sounds were heard in the right axilla and lower anterior portion of the chest. The temperature was 104° F., pulse 120, and respirations 24 per minute. The white blood count was 17,800, with 87 per cent polymorphonuclear leukocytes. A pneumococcus, type VII, was re-

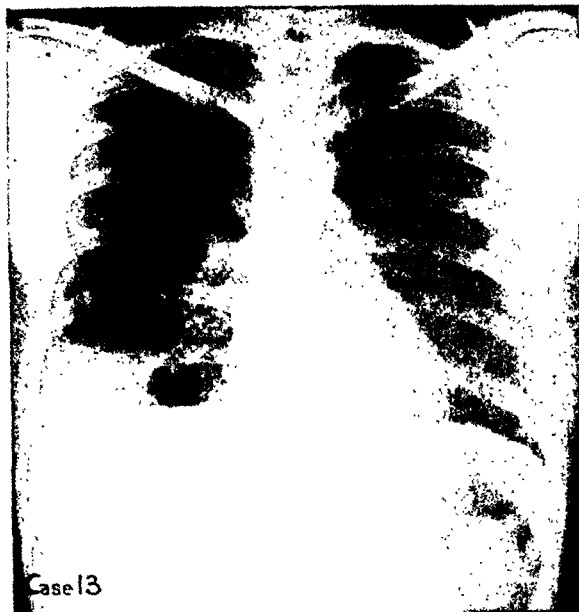


Fig. 13. Pneumococcal pneumonia.



Fig. 14. Primary atypical pneumonia.

covered from the sputum. Roentgen study of the chest revealed an increased mottled density in the lower portion of the right upper lobe, apparently radiating from the right hilum, consistent with a pneumonia. The patient made an uneventful recovery on sulfadiazine therapy.

CASE 12: Pvt. R. P. T., aged 21, was admitted to the station hospital on Sept. 8, 1942, with a wracking cough of two weeks' duration, sore throat and hoarseness, malaise, and fever. Physical examination revealed a slight impairment of resonance at the right base but no definite signs of pneumonic consolidation. The temperature was 102° F., pulse 100, and respirations 20 per minute. Roentgen study of the chest on Sept. 17, 1942, showed an increased mottled density in the right upper lobe with a curved atelectatic lower border, suggestive of a tuberculous infiltration. The white blood count was 13,350, with 75 per cent polymorphonuclear leukocytes. Several sputum examinations proved negative for acid-fast organisms. In nine days the pneumonic lesion had resolved completely. A diagnosis of primary atypical pneumonia was made.

The pneumonias in the three cases just described were all in the right upper lobe. Case 10 was a pneumococcal pneumonia, type II, and Case 11 was a pneumococcal pneumonia, type VII. The clinical histories, bacteriologic findings, and response to sulfonamide therapy in both cases left no doubt of their pneumococcal etiology. On roentgen study (Figs. 10 and 11), however, both pneumonias seemed to originate from the hilar region and spread

in a fan-shaped fashion into the right upper lobe. From the x-ray appearances *alone*, therefore, a diagnosis of primary atypical pneumonia would be justified; yet such a diagnosis would have been grossly inaccurate.

Case 12 is a primary atypical pneumonia of the right upper lobe (Fig. 12). The roentgen shadow here has the appearance of tuberculosis. Particularly noteworthy in this case is the curved, atelectatic lower margin of the lesion, so frequently seen in tuberculous infiltrations. A diagnosis of tuberculosis in this case was excluded only after the lesion had undergone complete resolution and repeated examinations of the sputa proved negative for tubercle bacilli.

CASE 13: Pvt. G. R. B., aged 22, was admitted to the station hospital on May 2, 1943, with sharp pain in the right chest which became aggravated by coughing or deep breathing, accompanied by chills and fever, with some bloody sputum. Dullness, bronchovesicular breath sounds, and fine crepitant râles were elicited over the right lower lobe area. The temperature was 103.6° F., pulse 92, and respirations 20 per minute. The white blood count was 29,800, with 88 per cent polymorphonuclear leukocytes. A pneumococcus, type V, was recovered from the sputum. Roentgenograms of the chest showed a homogeneous increased density, with indistinct peripheral edges, in the right lower lobe. The diagnosis was pneumococcal pneumonia, type V. The

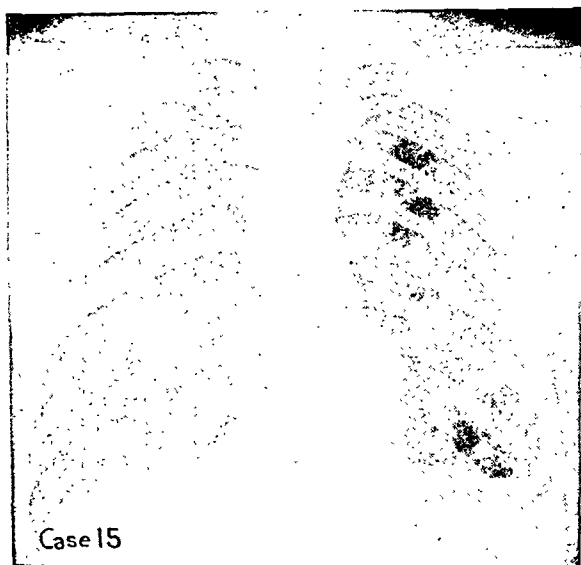


Fig. 15. Pneumococcal pneumonia.

patient made an uneventful recovery with sulfadiazine therapy.

CASE 14: Pvt. C. C. H., aged 32, was admitted to the station hospital on April 14, 1943, complaining of a wracking cough productive of a moderate amount of mucoid sputum for three months, with generalized aches and pains and some chilly sensations setting in three days prior to admission. There were crepitant râles at both bases, more marked at the left base. The temperature was 100.4° F., pulse 100, and respirations 24 per minute. The white blood count was 9,900, with 77 per cent polymorphonuclear leukocytes. Roentgen study of the chest revealed a mottled increased density in the left lower lobe consistent with a pneumonia. A smaller but similar density was seen in the right lower lobe. A diagnosis of primary atypical pneumonia was made.

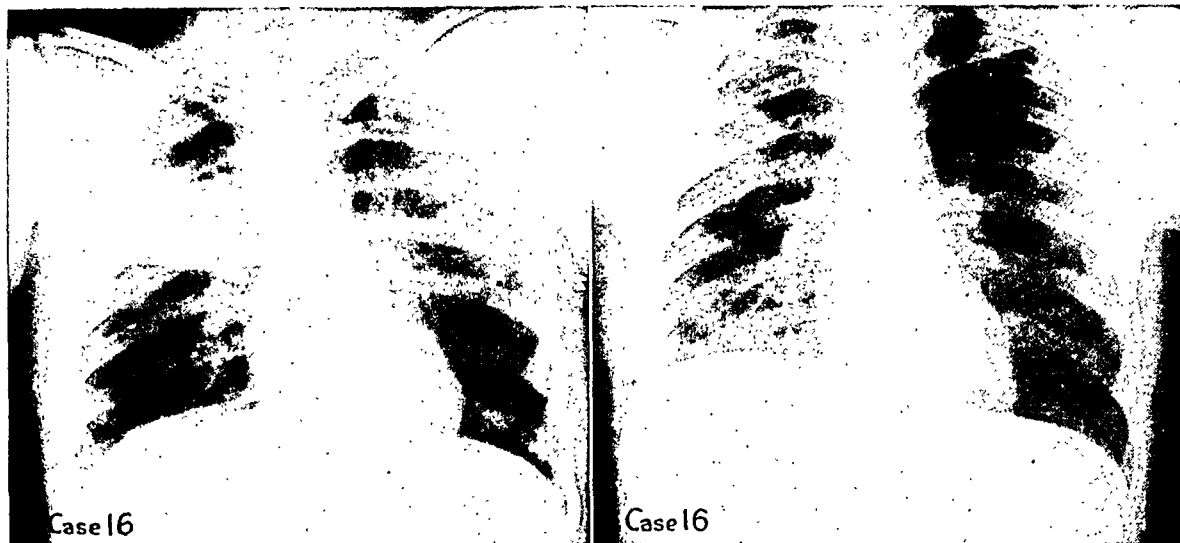
Case 13 is a pneumococcal pneumonia, type V, located in the right lower lobe. Case 14 is a primary atypical pneumonia with involvement of the left lower lobe. Roentgenographically (Figs. 13 and 14) the two lesions are very similar; etiologically, they are different.

CASE 15: Sgt. L. H. B., aged 21, was admitted to the station hospital on March 24, 1943, with a slight cough, present for two days, pain in the right chest, fever, vomiting, and expectoration of bloody sputum several hours before admission. Dullness and diminished breath sounds were elicited over the right lower lobe area and a few coarse râles were heard at the left base. The patient's temperature was 104.6° F., pulse 112, and respirations 38 per minute. The white blood count was 35,000, with 92 per cent polymorphonuclear leukocytes. A pneu-

mococcus, type II, was recovered from the sputum. Roentgen study of the chest revealed a small mottled increased density in the region of the right cardiophrenic angle which could not be definitely interpreted as a pneumonia. The patient was given sulfadiazine therapy and progressed satisfactorily. Further roentgen study, March 28, 1943, showed the small mottled area to have increased in size, density, and distribution, so that the pneumonia was apparent. At the time of the second roentgenogram the patient's temperature was normal and he was convalescent from the acute infection.

CASE 16: Pvt. R. T. C., aged 21, was admitted to the station hospital on April 11, 1943, with severe chilly sensations, pain in the right chest, and expectoration of some bloody sputum. Signs of frank consolidation were elicited over the right interscapular area posteriorly. The temperature was 104.2° F., pulse 103, and respirations 30 per minute. The white blood count was 19,700. A pneumococcus, type VII, was recovered from the sputum. Roentgen study of the chest showed a dense consolidation in the lower half of the right upper lobe. A diagnosis of bacterial pneumonia, type VII, was made. The patient had an uneventful recovery with sulfadiazine therapy. A roentgenogram, taken on April 22, 1943, during convalescence, showed a resolving lobar pneumonia with a shadow indistinguishable from that of a primary atypical pneumonia (a linear increased mottled density radiating from the right hilum into the periphery).

One of the most important factors in the evaluation of the roentgenogram in cases of pneumonia is the stage of the pneumonia at the time of the roentgen examination. Most pneumonia patients admitted to the station hospital here were in a very early phase of the illness. Hence most of the roentgen films portrayed the incipient changes in the lungs, before the stage of maximum consolidation was reached. Case 15 is a pneumococcal pneumonia, type II. The admission film in this case (Fig. 15) shows a mottled density in the right cardiophrenic angle area. If the roentgenologist were to venture a diagnosis on the basis of this one film, he would undoubtedly designate the condition as a primary atypical pneumonia. At the time this roentgenogram was made, however, the patient had a temperature of 104.6° F., he was experiencing pleuritic pain, expectorated bloody sputum, and was extremely toxic. Four days later a repeat roentgen examination revealed a definite homogeneous area of consolida-



Figs. 16 and 17. Pneumococcic pneumonia. The left-hand film was made at the height of the disease; the other eleven days later, when resolution was well under way.

tion. At this time, all of the acute symptoms had subsided.

During the resolving stage of a bacterial pneumonia, the roentgen appearance may resemble a primary atypical pneumonia. The first roentgen examination (Fig. 16) in Case 16 (which proved to be a type VII pneumococcic pneumonia) was made at the height of the disease and showed a dense pneumonic consolidation in the right upper lobe. A film taken eleven days later (Fig. 17), when resolution of the process was well under way, resembled fairly closely the picture described as "classical" for a primary atypical pneumonia. It presented a striated increased density extending from the right hilum. If the roentgenologist were not aware that this was a resolving bacterial pneumonia, he might interpret the roentgenogram as one of a primary atypical pneumonia.

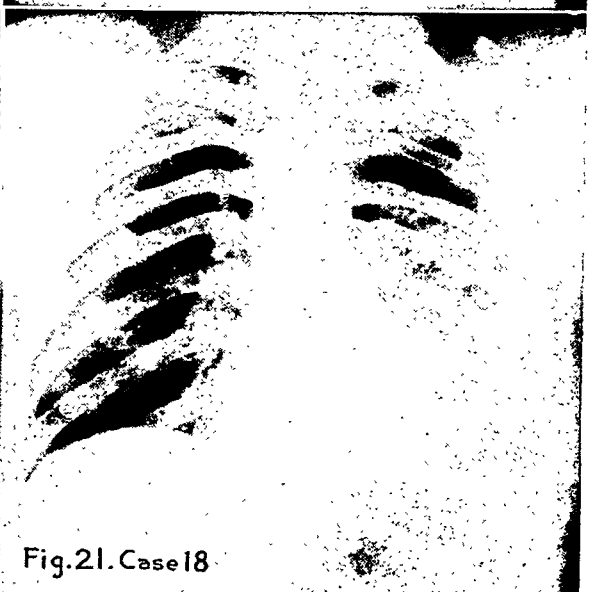
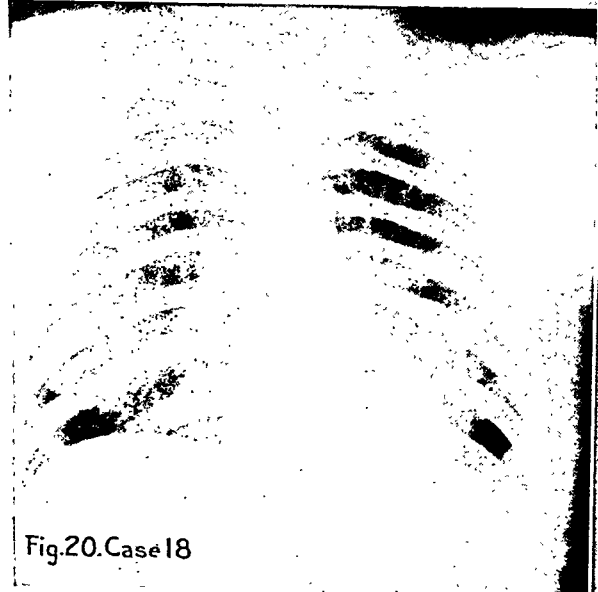
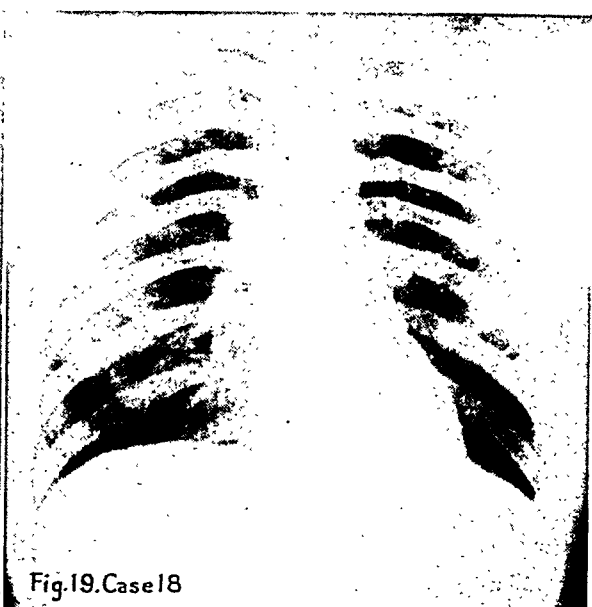
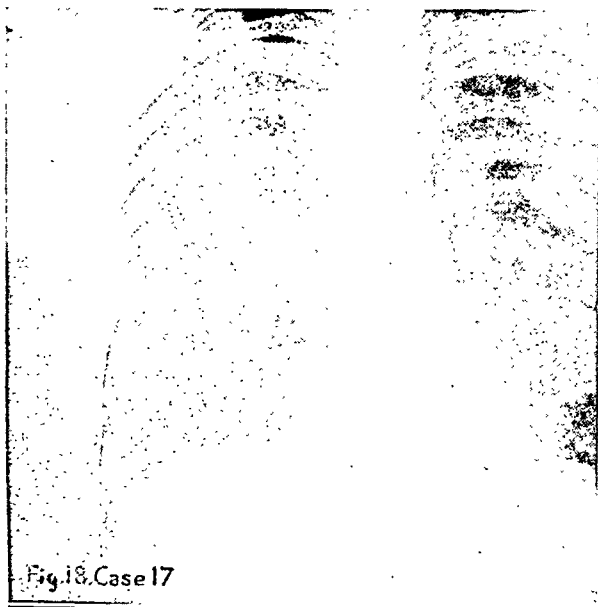
CASE 17: Pvt. A. R. O., aged 44, was admitted to the station hospital on May 27, 1943, with a history of a mild hacking cough for one week prior to admission. Roentgen study revealed a mottled increased density in the right hilum and the lower portion of the right upper lobe, consistent with a pneumonia. The temperature on admission was 98.6° F., pulse 74, and respirations 16 per minute. A few coarse râles were heard along the right sternal border. The patient remained afebrile during his entire hospital stay. A follow-up roentgenogram taken on July 9, 1943, showed complete resolution

of the lesion. The case was diagnosed as a primary atypical pneumonia.

CASE 18: Pvt. W. J. C., aged 20, was admitted to the station hospital on April 17, 1943, complaining of cough, chills, fever, and pain in the left chest for one week, with expectoration of some rusty sputum on the day of admission. Physical examination revealed some fine moist râles over the left base. The temperature was 103.2° F., pulse 88, and respirations 22 per minute. The white blood count was 24,800, with 96 per cent polymorphonuclear leukocytes. A pneumococcus, type II, was recovered from the sputum. Roentgen study, April 17, 1943, revealed no radiographic evidence of a pneumonia. The patient was given sulfathiazole, which was continued for thirteen days. Further roentgen study, April 22, 1943, revealed a haze adjacent to the left cardiac border, suggestive of a beginning pneumonia. A definite homogeneous density characteristic of a pneumonia involving the left lower lobe area was seen on the roentgenogram of April 25, 1943. By this time, the patient had already responded to the sulfathiazole therapy and was greatly improved clinically. On May 3, an effusion developed in the left chest, which took forty days to become completely resorbed. Some residual pleural thickening remained at the time of discharge from the hospital.

We have found that in pneumonia there is no correlation between the amount of consolidation evident on the roentgenograms and the severity of the clinical symptoms. The amount of pulmonary exudate is not directly proportionate to the virulence of the disease. Either type of pneumonia may show anything from a slight bronchitic streaking to a consolida-





Figs. 18-21. Case 17. Primary atypical pneumonia. Case 18. Pneumococcic pneumonia.

tion. Case 17 is an example of what is frequently referred to as a "walking pneumonia." The patient was not ill except for a mild, hacking, unproductive cough, which was in no way incapacitating. Routine roentgen examination (Fig. 18) revealed the pneumonic process in the right upper lobe, the size, density, and distribution of which were entirely disproportionate to the clinical symptoms. Resolution was complete in twelve days.

Case 18, a pneumococcic pneumonia, type II, is presented for contrast. The

first roentgenogram (Fig. 19) revealed negative findings in the face of indubitable symptoms and laboratory findings confirming the presence of a pneumococcic pneumonia, type II. Five days later roentgen study (Fig. 20) revealed a slight haze along the left cardiac border. On the eighth day of hospitalization, a definite pneumonia was present (Fig. 21). If an opinion were ventured on the first chest film, taken at the height of the illness, the roentgen interpretation would be bronchitic changes in the right cardiophrenic angle.

CASE 19: Pvt. J. F. W. G., aged 33, was admitted to the station hospital on May 6, 1943, with a cough of five days' duration and chills and fever on the day of admission. There were impaired resonance, harsh breath sounds, and crepitant râles over both lower lobes. The temperature was 101.8° F., pulse 112, and respirations 22 per minute. The white blood count was 18,400, with 90 per cent polymorphonuclear leukocytes. A pneumococcus, type II, was recovered from the sputum. Roentgen study of the chest, May 11, 1943, revealed a spherical mottled density with feathered edges in the right lower lobe. In the left lower lobe area was seen a homogeneous increased density. Both lesions were consistent with pneumonia. The patient made an uneventful recovery with sulfadiazine therapy.

This case was one of bilateral pneumonia (Fig. 22). In the right lower lobe a spherical area of consolidation was seen, the edges of which were feathered and seemed to merge imperceptibly into the surrounding tissue. This lesion resembled the type of shadow described as characteristic for primary atypical pneumonia. The left lung contained an area of consolidation of homogeneous density, demarcated from the surrounding pulmonary parenchyma. On the basis of the roentgen findings alone, the diagnosis would be a primary atypical pneumonia on the right and a bacterial pneumonia on the left. The patient actually had a type II pneumococcal pneumonia. There is no clinical reason for suspecting a coexistent atypical pneumonia. It is probable that one organism, the type II pneumococcus, was responsible for both lesions. The right lung reacted by producing one type of exudative process and the left lung responded in an entirely different manner. Variation in the tissue response is, therefore, an important factor in determining the roentgen appearances of the pneumonic process.

#### SUMMARY AND COMMENT

Nineteen cases, representing a cross-section of over 2,000 pneumonias are reported. We have been impressed by the variability of the roentgen shadow during the course of both bacterial and primary atypical pneumonia. From the evaluation of our large number of serial roentgen studies of the chest in both types of pneu-

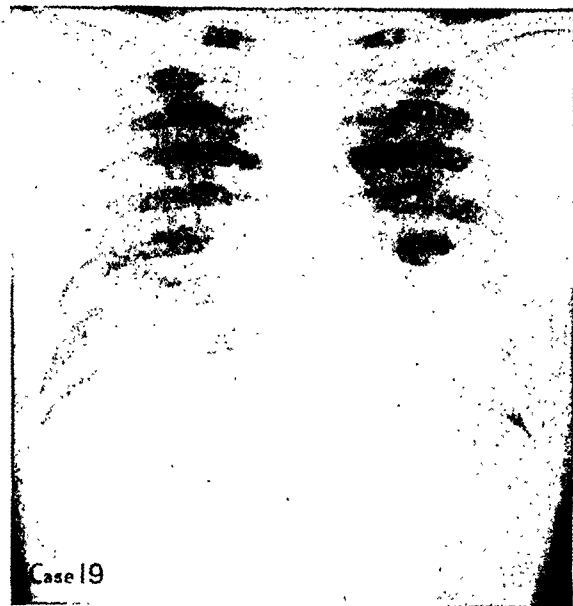


Fig. 22. Bilateral pneumococcal pneumonia.

monia, we are convinced of the fallacy of employing rigid roentgenologic criteria to differentiate the two. Any attempt to establish an *etiological* diagnosis from the roentgen findings *alone*, without a knowledge of the clinical symptomatology, laboratory findings, and clinical course, is certain to result in inaccurate diagnoses.

NOTE: Acknowledgment is made to the post surgeon, ward officers, and technicians for their cooperation and assistance.

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#### REFERENCES

1. RIGLER, L. G.: X-Ray Observations in Pneumonia. *Minnesota Med.* 9: 611-620, November 1926.
2. BOWEN, A.: Acute Influenza Pneumonitis. *Am. J. Roentgenol.* 34: 168-174, August 1935.
3. KORNBLUM, K., AND REIMANN, H. A.: Roentgenological Aspects of an Epidemic of Acute Respiratory Infection. *Am. J. Roentgenol.* 44: 333-344, September 1940.
4. DINGLE, J. H., AND FINLAND, M.: Medical Progress: Virus Pneumonias. II. Primary Atypical Pneumonias of Unknown Etiology. *New England J. Med.* 227: 378-385, Sept. 3, 1942.
5. SEEDS, A. E., AND MAZER, M. L.: Virus Pneumonia: Roentgenographic Characterizations of Recent Virus Pneumonitis with Bronchopneumonia. *Am. J. Roentgenol.* 49: 30-38, January 1943.
6. DINGLE, J. H., ET AL.: Primary Atypical Pneumonia, Etiology Unknown. *War Med.* 3: 223-248, March 1943.
7. MOORE, G. B., JR., TANNENBAUM, A. J., AND SMAHA, T. G.: Atypical Pneumonia in an Army Camp. *War Med.* 2: 615-622, July 1942.

# Roentgen Study of Primary Atypical Virus Pneumonia<sup>1</sup>

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SMALL EPIDEMICS of virus pneumonia have been prevalent in this country since the fall of 1935. Since the disease is usually not fatal, there has been comparatively little pathologic material available for study. There appear, however, to be certain clinical, roentgenologic, and laboratory findings which help to form a fairly clear picture of the entity. This report is based on a study of 100 consecutive cases observed in the Department of Radiology of the Massachusetts Memorial Hospitals.

## ETIOLOGY

Virus pneumonia is probably due to a filtrable virus, which has not yet been identified. Eaton, Beck and Pearson (1), discussing the cases described by Reimann (11), Kneeland and Smetana (5), and by Longcope (10), state that atypical pneumonia presents clinical similarities to cases of recognized psittacosis. They believe that the causative agent in some instances may be antigenically related to the virus of meningopneumonitis and psittacosis. Nigg (2) was able to produce pneumonia and systemic infection in mice with a virus similar in antigen relationship to the viruses described for psittacosis and lymphogranuloma venereum. Another possibly related form is suggested by the report of Adams, Green, Evans and Beach (3), who studied two epidemics of virus pneumonitis. They observed that, while every infant exposed to the disease became ill, adults showed a relative immunity. Their attempts to transmit the disease to mice or guinea-pigs were unsuccessful. Inclusion bodies were found in these cases, whereas none has been demonstrated at autopsy in virus pneumonia. Finland and Dingle

(4) state that the white cell count may become elevated without any evidence of secondary bacterial invasion. Most observers are now of the opinion that bacterial invasion is rare or absent. According to Kneeland and Smetana (5), "secondary bacterial infection occurred so rarely as to make it seem that the disease might actually predispose against it."

## SYMPTOMS

The symptoms vary with the severity of infection. They may be so mild as to go unrecognized, or they may be entirely out of proportion to the physical findings. They may be insidious in appearance, patients being unable to date their exact onset. The principal complaint is cough, soon followed by fever and malaise. The patient may diagnose his own condition as a "cold" and dismiss it lightly. In a few days, however, the intensity of symptoms increases. Fever may rise to 103° or 104°, or even higher. Coughing becomes more frequent and severe and may be productive of white, tenacious sputum. There may be pain in the chest and possibly also in the extremities. These may be associated with prostration, dyspnea, and cyanosis. The average duration of symptoms in our cases at the time of hospital entry was seven days.

## CLINICAL AND LABORATORY FINDINGS

Except in mild cases, patients showed a varying degree of prostration. There was a dry, rasping cough accompanied by pain in the chest. In the moderate and severe infections cyanosis was often present. Physical examination showed hyperemia of the pharynx varying in manifestation from moderate redness to intense injection.

In the typical case, percussion often revealed normal resonance throughout both lungs, though areas of flatness were not

<sup>1</sup> From the Evans Memorial, and the Department of Radiology, Massachusetts Memorial Hospitals, Boston, and the Department of Radiology, Boston University School of Medicine. Accepted for publication in July 1943.

rare. Fine, crepitant, inspiratory râles or coarse rhonchi could be heard on one or both sides, or were absent altogether. As Longcope (6) points out, there was marked disparity between the physical and roentgen findings in the lungs.

The white cell count varied. A few patients showed leukopenia or no departure from normal. In 80 per cent of our cases there was a leukocytosis at the time of hospital entry. Blood cultures were negative. Sputum smears and cultures revealed the usual microorganisms resident in the throat: diphtheroids, streptococci, staphylococci, *Micrococcus catarrhalis*.

Urinalysis frequently showed varying amounts of albumin, probably due to toxic nephritis. There was no other significant finding.

#### PATHOLOGY

The initial lesion of virus pneumonia is a severe tracheobronchitis. There are proliferation and sloughing of the bronchial epithelium, and epithelial exudate fills the bronchial lumen. The walls of the smaller bronchi become necrotic (7). As the inflammation extends into the lungs, a severe peribronchitis is set up, so that at this stage the lesions are interstitial.

The pathologic process is destructive and entirely different from the inflammatory exudates seen in pneumococcal pneumonia (6). In the comparatively few autopsied cases reported in the present epidemic (5, 8, 9, 10) the lungs were found to be red and edematous. There were small areas of focal or lobular atelectasis, some of which coalesced to form larger areas, as well as areas of emphysema. The alveoli contained chiefly mononuclear cells, erythrocytes, and coagulated serum. Fibrin was lacking. An occasional hyaline membrane was present, and edema fluid often filled the alveoli. The tracheobronchial system showed areas of necrosis, the predominating cells in these regions being polymorphonuclear leukocytes. Thrombosis of the smaller branches of the pulmonary artery has been observed. The fact that abnormal signs and roentgeno-



Fig. 1. Bedside roentgenogram of fatal case of virus pneumonia. There is consolidation at the right base. Note the mottled density and low right diaphragm due to emphysema. The intercostal spaces are not narrowed. These changes distinguish consolidation in virus pneumonia from pneumococcal pneumonia.

Male, age 62 years; duration of illness 4 days. Temp. 105.6°. WBC 10,000. Sputum: diphtheroids, streptococci with alpha hemolysis, *M. catarrhalis*. Blood culture: no growth.

graphic shadows persisted so long in some cases suggested to Reimann (11) that the interstitial tissue was severely damaged.

In our series, one case uncomplicated by other disease terminated fatally. Microscopic study revealed changes which resembled "influenzal" rather than bacterial pneumonia. There were scattered areas of focal atelectasis and emphysema. A hyaline membrane lining the alveoli was frequently observed. There was monocytic infiltration and some fibrin was present (Figs. 1 and 2).

#### ROENTGENOLOGIC APPEARANCE

The earliest change in virus pneumonia appears as a tracheobronchitis. There are hazy shadows in one or both hilar regions and increased prominence of the bronchial markings. The lungs are luminous and the diaphragm is low (Fig. 3). As the disease progresses, the bronchial

markings become wider and more hazy and there is more or less dense, linear infiltration following the course of the bronchi. The appearance at this time is that of a peribronchitis or interstitial pneumonia (Fig. 4). The lung in the involved region has a diminished radiolucency, while the peripheral portions are emphysematous. Small dense areas of

tasis, such as narrowing of the intercostal spaces, shift of the heart to the affected side, and elevation of the diaphragm, are found infrequently, because of associated emphysema, whereas they are usually present in pneumococcal pneumonia.

With the onset of resolution, the minute areas of atelectasis and edema in the peripheral areas of the lung begin to disappear,

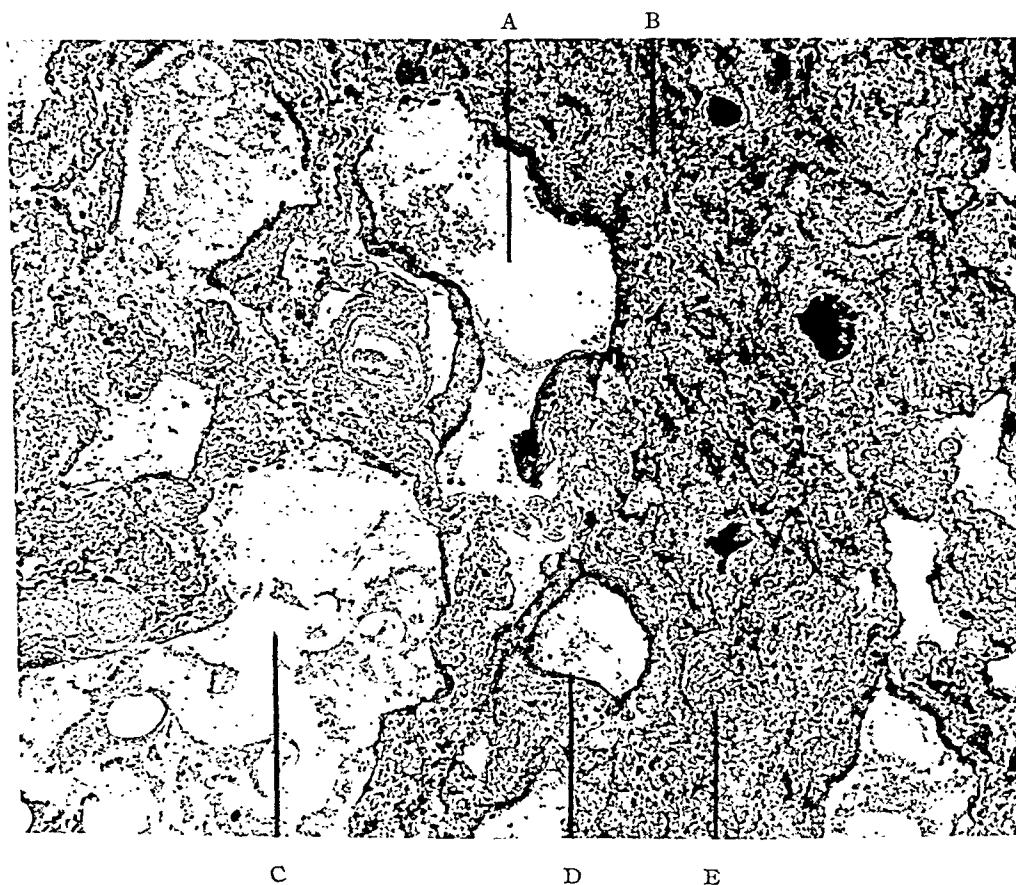


Fig. 2. Photomicrograph of lung from case shown in Fig. 1. A. Edema fluid. B. Atelectasis. C. Emphysema. D. Hyaline membrane. E. Endothelial infiltration and fibrin. Zenker fixation. Phloxine-methylene-blue stain.  $\times 140$ .

atelectasis and edema having a bronchial distribution soon appear and may coalesce (Fig. 5). When coalescence occurs, the area of consolidation is usually not of such uniform density as in lobar pneumonia but has a coarsely mottled appearance. Moreover, the disease has a tendency to involve only a portion rather than an entire lobe. The most extensive changes are usually seen in the middle and lower parts of the lungs. The signs of gross atelec-

the process extending centripetally toward the hilum (Fig. 6). This is in contrast to the resolution usually observed in bacterial pneumonias, in which resolution proceeds from the hilum (12). At this stage the lungs are quite luminous and are traversed by numerous coarse lines which radiate fanwise from the lung roots. Sometimes the peripheral portions show a coarse network. Subsequently resolution proceeds much more slowly, the linear infil-

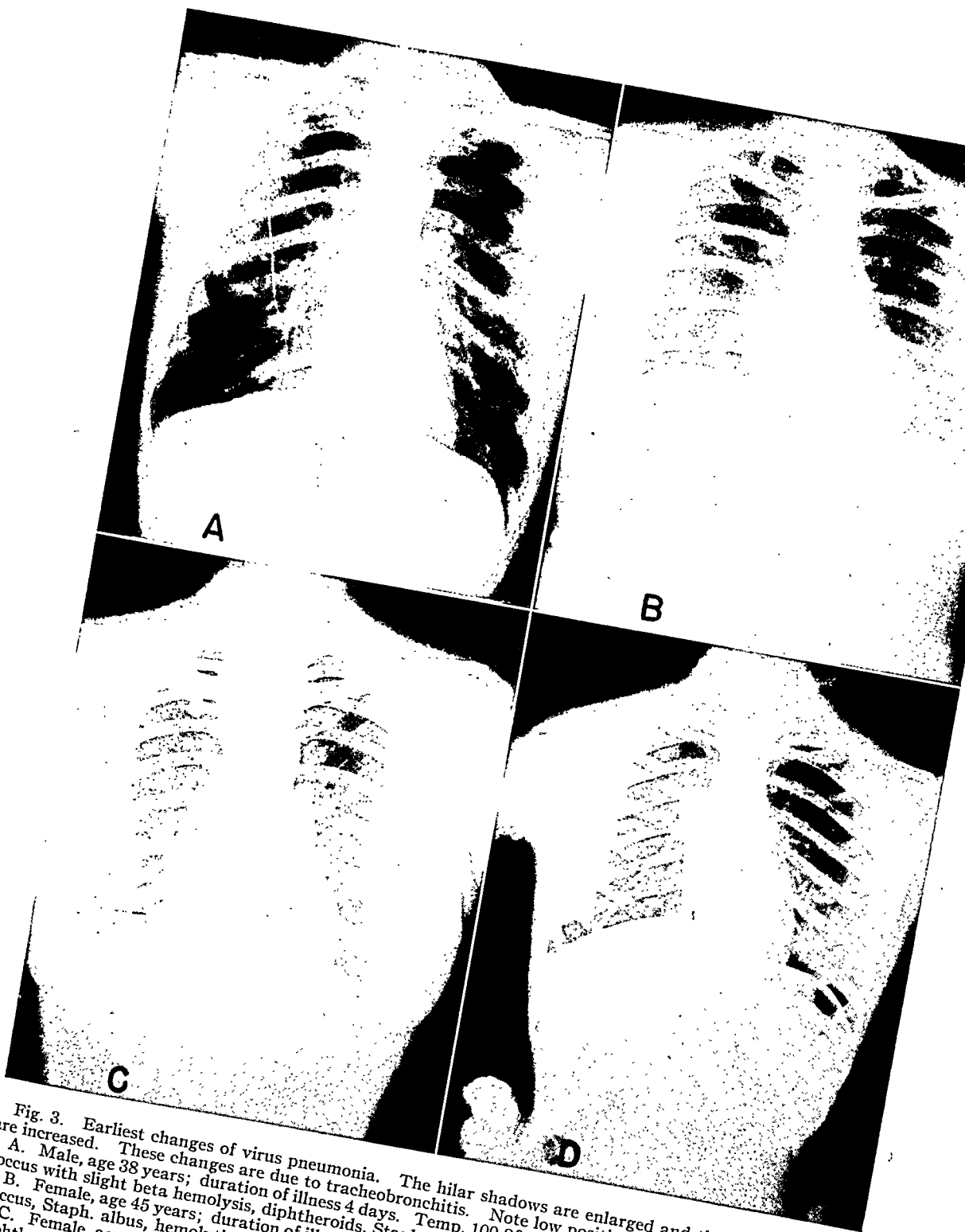


Fig. 3. Earliest changes of virus pneumonia. The hilar shadows are enlarged and the linear markings are increased. These changes are due to tracheobronchitis. Note low position of diaphragm.

A. Male, age 38 years; duration of illness 4 days. Temp. 100.8°. WBC 8,900. Throat culture: streptococcus with slight beta hemolysis, diphtheroids, Staph. albus. Blood culture: no growth.

B. Female, age 45 years; duration of illness 1 day. Temp. 101°. WBC 10,000. Sputum: alpha streptococcus, Staph. albus, hemolytic Staph. aureus. Blood culture: no growth.

C. Female, age 44 years; duration of illness 4 days. Temp. 101°. WBC 8,500. Sputum: Staph. albus, diphtheroids, M. catarrhalis. Blood culture: no growth.

D. Female, age 12 years; duration of illness 3 days. Temp. 101.6°. WBC 11,600. Sputum: M. catarrhalis, Staph. albus.

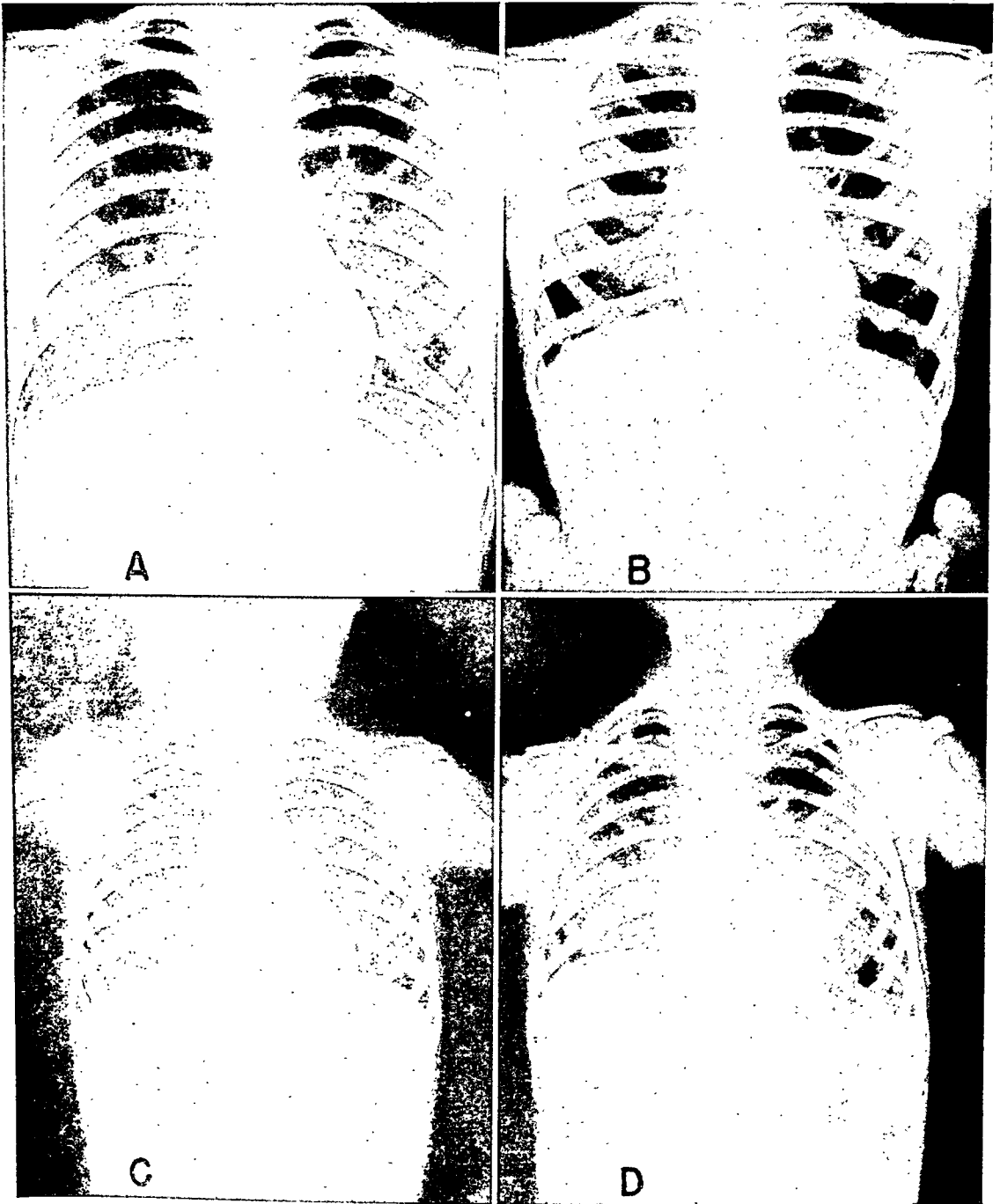


Fig. 4. Further progress of the disease. At this time there is evidence of interstitial pneumonitis. Note the absence of signs of gross atelectasis.

A. Male, age 9 years; duration of illness 10 days. Temp. 101.4°. WBC 17,700. Throat culture: alpha streptococcus, Staph. albus, Strep. viridans, diphtheroids, M. catarrhalis. Blood culture: no growth.

B. Female, age 6 years; duration of illness 9 days. Temp. 102.8°. WBC 8,700. Throat culture: Streptococcus with alpha hemolysis, M. catarrhalis, diphtheroids; K.L. negative. Blood culture: no growth.

C. Male, age 2 years; duration of illness 2 days. Temp. 103.6°. WBC 10,600. Throat culture: Strep. viridans, Staph. albus, diphtheroids. Blood culture: no growth.

D. Female, age 3 years; duration of illness 2 days. Temp. 102°. WBC 12,000. Throat culture: alpha streptococcus, M. catarrhalis, diphtheroids; K.L. negative.



Fig. 5. Further progress of the disease. There is coalescence of atelectatic foci. These areas lack the homogeneous consolidation seen in pneumococcal pneumonia, and consolidation usually involves only a portion of a lobe (D). Note that the diaphragm is not elevated. This is due to the presence of emphysema in association with atelectasis.

A. Female, age 10 years; duration of illness 10 days. Temp. 101.8°. WBC 25,500. Sputum: streptococcus with alpha hemolysis. Blood culture: no growth.

B. Male, age 21 years; duration of illness 5 days. Temp. 103.8°. WBC 14,500. Sputum: streptococcus with alpha hemolysis, *M. catarrhalis*, diphtheroids. Blood culture: no growth.

C. Female, age 26 years; duration of illness (?). Temp. 99°. WBC 6,050. Sputum culture: *Strep. viridans*, alpha streptococcus. Blood culture: no growth.

D. Male, age 24 years; duration of illness 7 days. Temp. 101.4°. WBC 8,850. Sputum: *Staph. albus*, streptococcus, *M. catarrhalis*. Blood culture: no growth.

tration or network occasionally persisting for weeks or months. In one of our cases there was no change in the roentgenologic

appearance of the lungs for fifty-two days, in spite of the fact that the patient was clinically well.



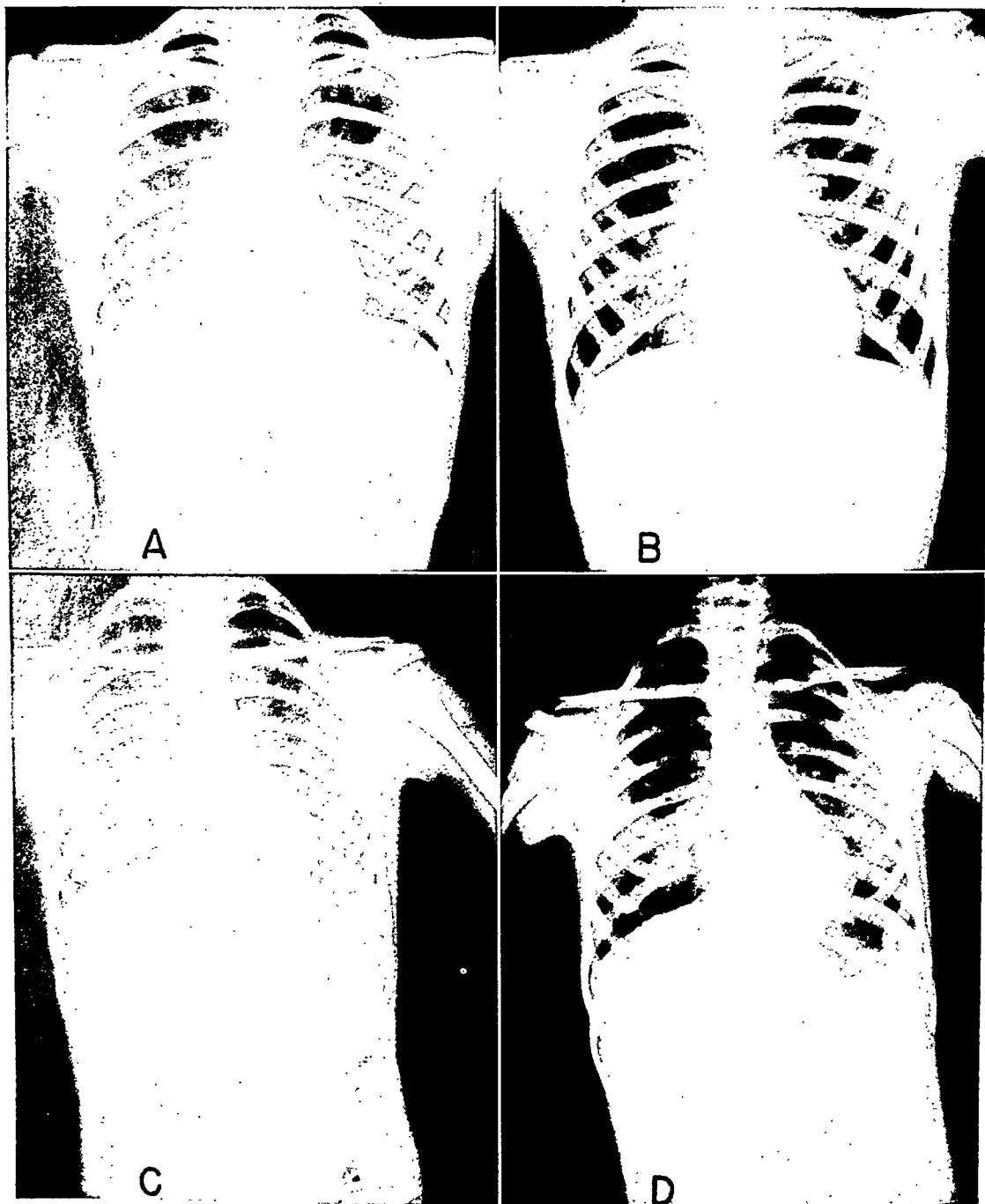


Fig. 6. Resolution proceeds centripetally from the periphery to the hilum. This is in contrast to the type of resolution usually seen in pneumococcal pneumonia.

A. Male, age 7 years; duration of illness 1 week (?). Temp. 101°. WBC 9,000. Sputum: Strep. hemolyticus, Staph. albus, diphtheroids. Blood culture: no growth.

B. Same patient as A, 11 days later.

C. Female, age 4 years; duration of illness 6 days. Temp. 105.8°. WBC 22,000. Throat culture: Strep. hemolyticus, Staph. albus, diphtheroids. Blood culture: no growth.

D. Same patient as C, 4 days later.

While resolution is taking place in one lobe, the process may appear anew in another lobe, or the same lobe may be

reinvolved after resolution has already occurred. This may be explained by the fact that the disease essentially involves

the tracheobronchial tree, allowing for easy dissemination to other foci during paroxysms of severe coughing. In general, complete resolution is slower than in pneumococcal pneumonias and may not be complete for weeks or months. Pleural effusion is usually absent.

During the course of the disease the roentgenologic appearance may vary considerably. The picture may simulate tuberculosis, lobar pneumonia, bronchopneumonia, abscess, bronchiectasis, metastatic carcinoma, or pulmonary edema, and the diagnosis may rest largely on the history and the clinical and laboratory findings, as well as serial chest films. Sante (13) has likened the appearance to the changes seen in pulmonary toxoplasmosis and to pulmonary edema. In these conditions, however, there is no emphysema. This feature serves to distinguish virus pneumonia.

Focal atelectasis in virus pneumonia is apparently due to a variable degree of bronchiolar obstruction and may appear at any stage of the disease. It is essentially different from the atelectasis of pneumococcal pneumonia, which is produced in the alveoli by accumulation of inflammatory exudate and absorption of residual air. Varying degrees of atelectasis may persist long after the patient is clinically well.

#### DISCUSSION

From a roentgenologic standpoint, virus pneumonia appears to be a disease of the tracheobronchial system with secondary changes in the lungs. Accumulation of inflammatory exudate in the bronchi results in the production of scattered small areas of atelectasis and emphysema. This is accompanied by interstitial inflammation. In our series, the average duration of symptoms at the time of admission to the hospital was seven days (Fig. 7). At this time there were positive findings in all of the chest roentgenograms. How much earlier these can consistently be found we are not able to say, though a few patients admitted on the first day of their illness showed evidence of acute tracheobron-

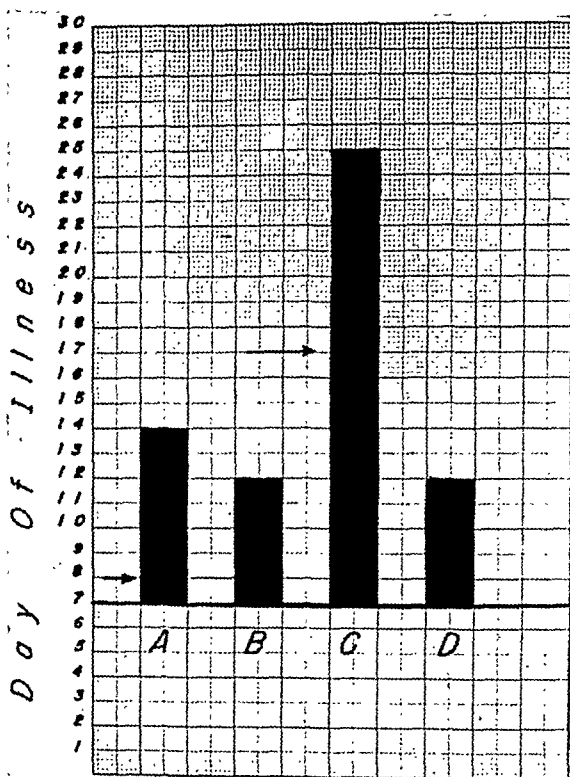


Fig. 7. Chart showing relation of roentgenologic findings to physical signs, fever, and leukocytosis. Average duration of illness at time of hospital entry, 7 days. A. Leukocytosis (present in 80 per cent of cases); arrow indicates day of highest count. B. Fever. C. Abnormal roentgen findings; arrow indicates day of average beginning resolution. D. Physical signs.

chitis. McCarthy (14) states that evidence of the disease appears on the films on the fourth day.

The lack of proportionately advanced physical findings in the chest may be explained partly by the presence of acute emphysema, which could readily mask small areas of atelectasis or consolidation. Roentgen examination is therefore important in determining the nature and extent of the disease. In a study of an institutional outbreak of pneumonitis, Hornibrook and Nelson (15) found that roentgen examination of the chest gave the most typical and consistent evidence of pulmonary lesions.

Kneeland and Smetana (5) found the average white cell count to be 10,000, though in two of their cases it reached 50,000. Leukocytosis was present in 80 per cent of our cases (Fig. 7). The average white cell count reached its highest on the

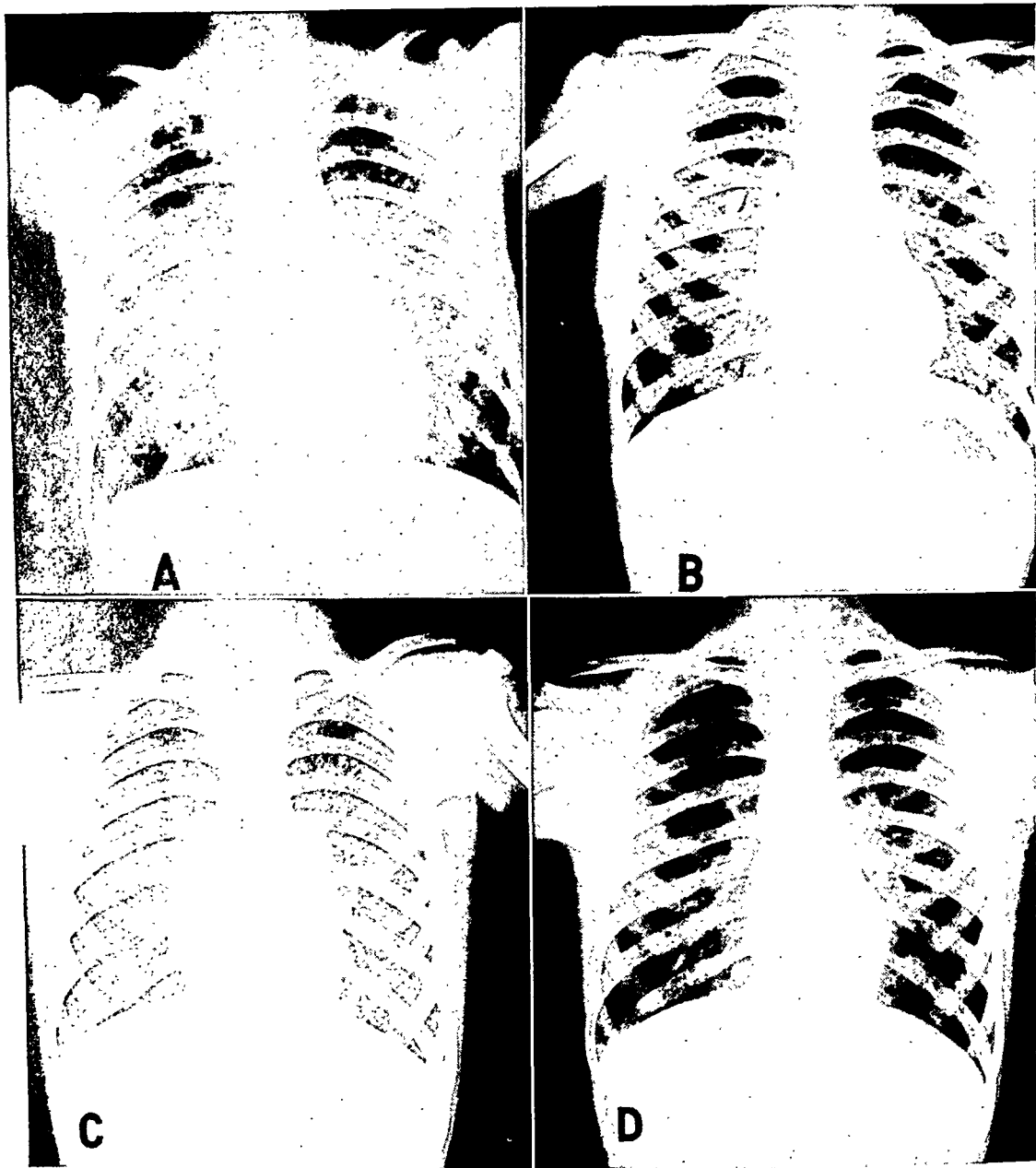


Fig. 8. A. Male, age 9 years; duration of illness 17 days. Temp. 101.4°. WBC 30,000. Sputum: *Staph. aureus*, *Strep. viridans*, diphtheroids. Blood culture: no growth. There is diffuse interstitial pneumonia with multiple areas of atelectasis and emphysema.

B. Same patient 11 days later. There is clearing from the periphery. Temp. 98.6°. WBC 15,000. Sputum and blood culture as before.

C. Same patient 29 days after B. Temp. 100.8°. WBC 24,000. Hilar shadows are increased, indicating reinfection.

D. Same patient approximately 13 weeks after C. Temp. 97.8°. WBC 8,600. There is no clinical evidence of disease. There is persisting roentgenologic evidence of interstitial pneumonitis involving medial portions of both lungs. Note presence of emphysema throughout entire course.

eighth day after onset of illness and returned to normal on the fourteenth day. The average day on which temperatures returned to normal was the twelfth.

In our series, roentgen changes persisted

longer than clinical signs or abnormal laboratory findings. All cases showed positive pulmonary findings on the roentgenograms taken on admission. On the average, clearing of the lung fields as shown

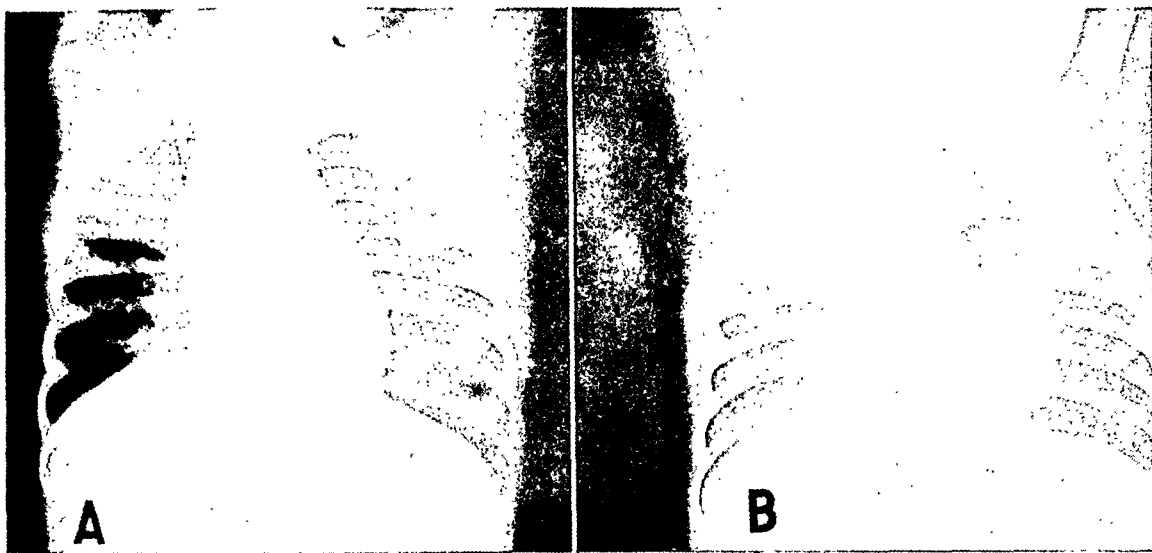


Fig. 9. Female, age 8 months; duration of illness 3 days. Temp. 105.4°. WBC 14,700. Throat smear: alpha streptococcus, *Staph. viridans*, and *Staph. albus*.

Film taken on admission (A) shows tracheobronchitis, multiple small areas of atelectasis, partial atelectasis of right upper lobe, and emphysema. There was progressive improvement for 5 days. On the 6th day (B) there was reappearance of fever (102°); WBC 9,700. Film shows reinfection of both lungs, persisting atelectasis, right upper lobe.

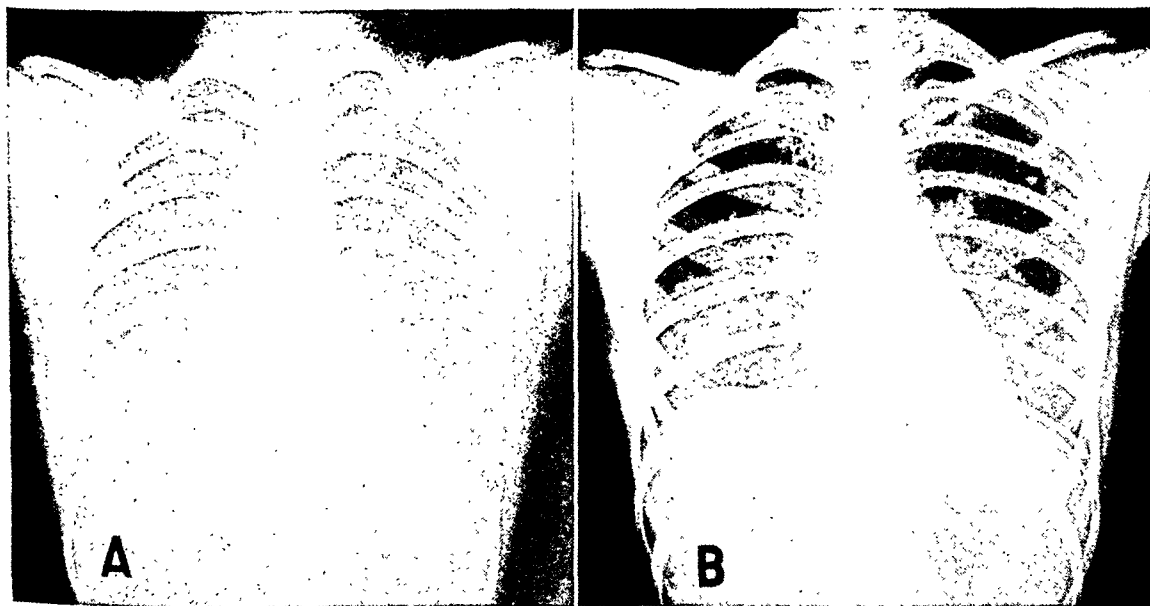


Fig. 10. A. Female, age 19 years; duration of illness 10 days. Temp. 98.6°. WBC 12,800. Sputum: *Staph. viridans*, diphtheroids. Blood culture: no growth. Film shows multiple areas of focal atelectasis having a bronchial distribution. Subsequently there was increase of fever and leukocytosis with the appearance of severe cyanosis and dyspnea.

B. Same patient 52 days later. Patient discharged as clinically well. Partial atelectasis and interstitial pneumonitis persist.

roentgenographically occurred on the seventeenth day. This consisted chiefly of resolution of areas of pneumonic consolidation or atelectasis (Fig. 8). In cases showing exacerbation due to involvement

of previously unaffected lung (Fig. 9), the duration of the disease was necessarily prolonged. In most cases, however, there was a persistence of peribronchial and perivascular thickening and emphysema.

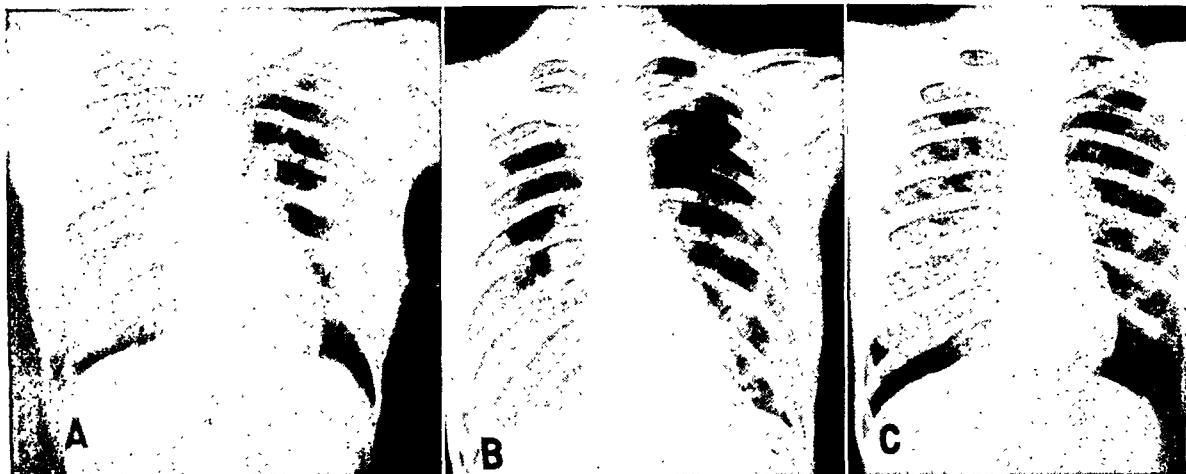


Fig. 11. A. Female, age 18 years; duration of illness 10 days. Temp. 103.8°. WBC 8,200. Sputum: *Staph. aureus*, *Staph. viridans*. Blood culture: no growth. Note multiple areas of atelectasis and edema in right lung together with generalized emphysema. The diaphragm is low. There is no gross atelectasis.

B. Same patient 8 days later. Temp. 98.6°. WBC 7,800. Blood culture: no growth. Film shows partial resolution.

C. Same patient 5 days after B (day of discharge). Temp. 98.6°. WBC 9,980. There is a residual network in the parenchyma and the hilar shadows are thickened. At this time patient was clinically well. (Check-up film taken 2 months later showed no residual evidence of disease.)

The average day for disappearance of all residual roentgenologic evidence of the disease was the twenty-fifth. This is in substantial agreement with the observations of Dingle and his associates (9), who found that the x-ray signs disappeared on the twenty-sixth day. They reported a persistence of physical signs, however, up to the fortieth day. The earliest complete resolution in our series occurred on the fourth day. The other extreme was a case which showed very little change in the roentgenologic appearance of the lungs in fifty-two days (Fig. 10). Except for occasional râles, the lungs were found clear on physical examination on the twelfth day.

The persistence of roentgenologic findings long after apparent clinical cure suggests the possibility of the development of chronic complications, particularly bronchiectasis. For this reason, it would appear to be good practice to take a roentgenogram of the chest on the day of discharge and another, where indicated, at a short interval thereafter (Fig. 11).

#### SUMMARY AND CONCLUSIONS

1. Virus pneumonia produces fairly characteristic pulmonary changes as shown

by roentgenologic examination. These consist of tracheobronchitis, peribronchitis, focal atelectasis, edema, and emphysema. The presence of emphysema militates against total lobar atelectasis, so that uniform consolidation is infrequently observed.

2. Roentgenograms show clearing of the lungs on the seventeenth day and a return to normal on the twenty-fifth day.

3. Resolution progresses centripetally, the peripheral portions of the lungs being the first to clear.

4. Roentgenologic evidence of interstitial pneumonitis and partial atelectasis may remain long after clinical cure.

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#### BIBLIOGRAPHY

1. EATON, M. D., BECK, M. D., AND PEARSON, H. E.: A Virus from Cases of Atypical Pneumonia: Relation to Viruses of Meningopneumonitis and Psittacosis. *J. Exper. Med.* 73: 641-654, May 1941.

## ROENTGEN STUDY OF ATYPICAL VIRUS PNEUMONIA

2. Nigg, C.: An Unidentified Virus Which Produces Pneumonia and Systemic Infection in Mice. *Science* 95: 49-50, Jan. 9, 1942.
3. ADAMS, J. M., GREEN, R. G., EVANS, C. A., AND BEACH, N.: Primary Virus Pneumonitis. A Comparative Study of Two Epidemics. *J. Pediat.* 20: 405-420, April 1942.
4. FINLAND, M., AND DINGLE, J. H.: Virus Pneumonias. I. Pneumonias Associated with Known Non-Bacterial Agents: Influenza, Psittacosis, and Q Fever. *New England J. Med.* 227: 342-350, Aug. 27, 1942.
5. KNEELAND, Y., JR., AND SMETANA, H. F.: Current Bronchopneumonia of Unusual Character and Undetermined Etiology. *Bull. Johns Hopkins Hosp.* 67: 229-267, October 1940.
6. LONGCOPE, W. T.: Pneumonitis or Virus Pneumonia. *Practitioner* 148: 1-8, January 1942.
7. BELL, E. T. (editor): *Text-Book of Pathology*. Philadelphia, Lea & Febiger, 4th ed., 1941.
8. KARSNER, H. T.: *Human Pathology*. Philadelphia, J. B. Lippincott Co., 6th ed., 1942.
9. DINGLE, J. H., ET AL.: Primary Atypical Pneumonia, Etiology Unknown. *War Med.* 3: 223-248, March 1943.
10. LONGCOPE, W. T.: Bronchopneumonia of Unknown Etiology (Variety X): Report of 32 Cases with 2 Deaths. *Bull. Johns Hopkins Hosp.* 67: 268-305, October 1940.
11. REIMANN, H. A.: Acute Infection of the Respiratory Tract with Atypical Pneumonia: Disease Entity Probably Caused by Filtrable Virus. *J. A. M. A.* 111: 2377-2384, Dec. 24, 1938.
12. BLAKE, F. G., AND CECIL, R. L.: Studies on Experimental Pneumonia. *J. Exper. Med.* 31: 403, May 1920.
13. SANTE, L. R.: Roentgen Manifestations of Adult Toxoplasmosis. *Am. J. Roentgenol.* 47: 825-829, June 1942.
14. MCCARTHY, P. V.: Primary Atypical Pneumonia of Unknown Etiology. *Radiology* 40: 344-346, April 1943.
15. HORNIBROOK, J. W., AND NELSON, K. R.: An Institutional Outbreak of Pneumonitis. *Epidemiological and Clinical Studies. Pub. Health Rep.* 55: 1936-1944, Oct. 25, 1940.

# Tomography in the Region of the Maxillary Sinuses<sup>1</sup>

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THE PURPOSE of this paper is to present the normal tomographic landmarks in the region of the maxillary antra and to compare them with certain abnormalities of these parts. The work now reported is part of a more complete study to be published later.

Although tomograms do not give distinct and detailed views of bony structures, they have the advantage of disclosing features which are obscured in ordinary roentgenograms by overlying and underlying bony structures and by certain soft tissues. Especially is this true in the field of cancer.

While serving as a visiting fellow of the Chicago Tumor Institute in 1938, Felix Leborgne of Montevideo, Uruguay, constructed a simple tomographic apparatus similar to one he had designed and previously described. The main features of this unit are its simplicity and economy. So far as we know, it was the first equipment of this type installed in this country.

A review of the literature of tomography discloses numerous publications, but for the most part these are limited to case reports. Leborgne (1, 2, 3) was the first to publish comprehensive studies of tomography with reference to abnormalities in a limited anatomical field, namely, cancer of the larynx. Caulk (4) has also contributed to the subject. Moore (5, 6, 7) has written extensively on the value of this type of roentgenography and is a pioneer in the field. In dental radiography the value of the tomogram has been demonstrated in temporomandibular joint abnormalities by Costen (8), Peyrus and Aubert (9), and Pippin and his associates (10). Cone, Moore, and Dean (11) have reported on the use of tomography of the paranasal sinuses

in ocular disorders due to disease of these chambers. Epstein (12) has recently published a report on the tomographic study of skull abnormalities. Abnormalities of the skull, larynx, and lungs are especially well shown by this technic.

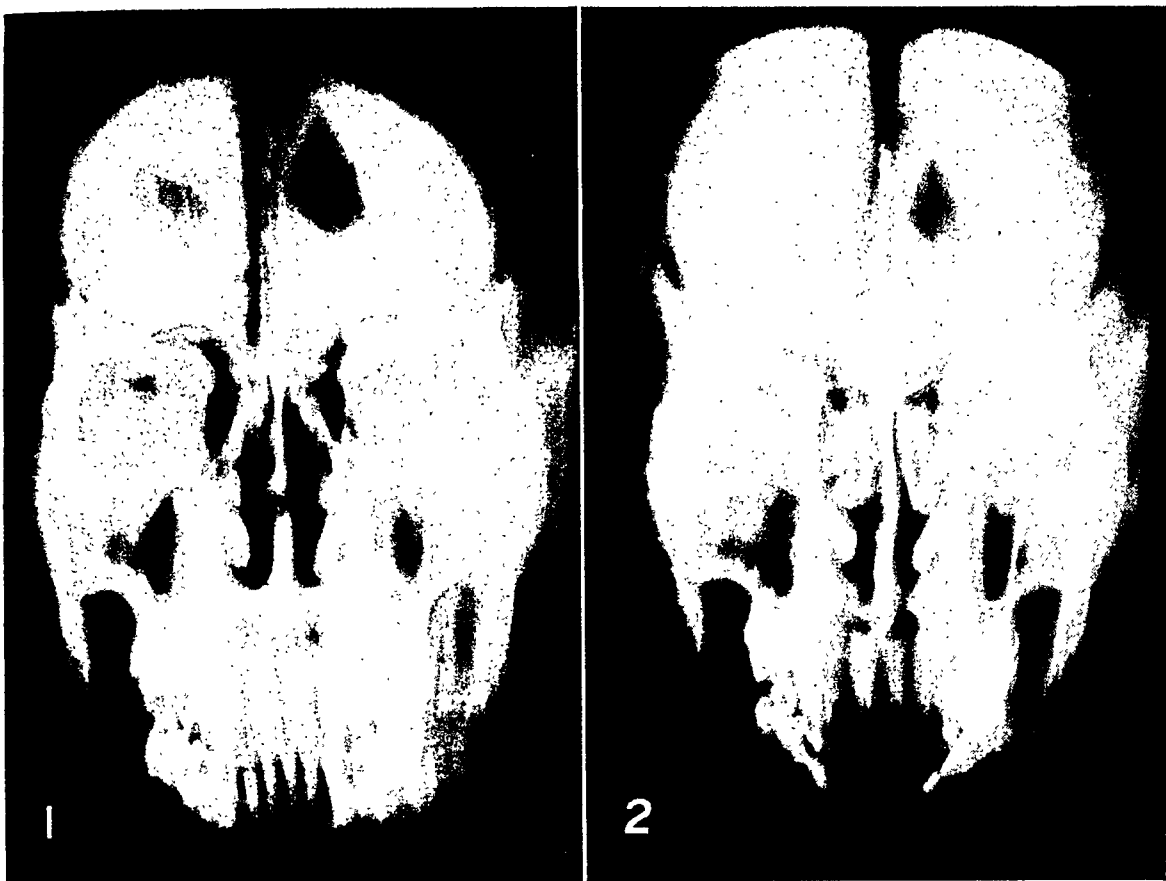
We have made a series of tomographic films at 0.5-cm. levels through the head of an adult cadaver in the anteroposterior projection. A similar study was made in the lateral projection, on another cadaver head. The present paper is concerned only with anteroposterior views at the level of the mid-portion of the maxillary sinuses.

Obviously, a clear conception of the features demonstrable by tomography can be obtained only by a comparison of successive adjacent levels. In this manner, a pathologic process can be followed from the point where it is first evident to the area where it is lost in normal bone architecture.

## NORMAL TOMOGRAPHY

Figure 1, taken 5.0 cm. from the table top, is at the level of the central and lateral incisor teeth. The floors of both atria are well outlined and rather sharp in detail. The anterior maxillary sinus septa are readily seen. The shadow cast by the lateral wall of the posterior portion of the maxilla is seen to bisect each antrum (designated here and in films to follow as the "H" line). It is not a septal image, with which it is sometimes confused. This line in deeper films is seen to approximate closely the linear shadow cast by the posterolateral wall of the frontal bone, the lateral wall of the greater wing of the sphenoid (in most part), and the wall of the anterior squamous portion of the temporal bone ("R" line). At this level, too, both atria extend well into the zygomatic arch, the inferior border of which is clear and well defined. The supraorbital sinuses are well

<sup>1</sup> This work has been aided by the Maurice I. Weil Memorial Fund. Accepted for publication in November 1943.



Figs. 1 and 2. Normal tomograms at level of central and lateral incisor teeth, 5.0 cm. from table top (1) and at the level of the canine teeth (2).

illustrated in this particular skull. Embryologically a portion of the ethmoidal air cells, these sinuses are forced anteriorly and laterally by the ethmoids and pneumatize that portion of the frontal bone immediately above the orbit and posterior to the true frontal sinuses. Like the frontal sinuses, these sinuses vary greatly in shape, and in some skulls they may be entirely absent. (The quite common failure of surgical procedures upon the frontal sinuses is attributed by many to the presence of infection within these supraorbital cells.)

The middle ethmoidal air cells are seen, as well as the lamina papyracea of the medial orbital wall. The crista galli is being lost to view. The inferior turbinates are coming into focus and are well delineated in deeper tomograms.

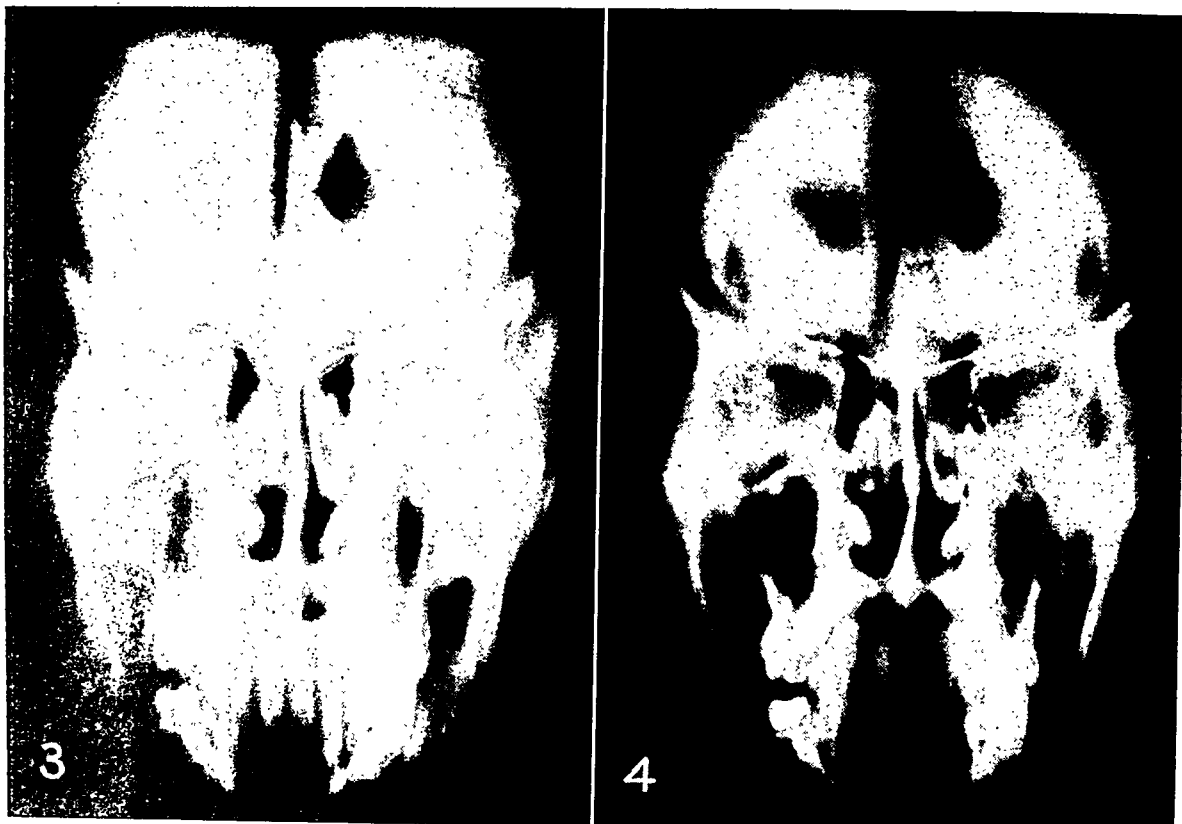
Because the skull is that of a cadaver, the lateral cerebral ventricles are neither uniform nor normal in size or shape and

they are quite distinctly visualized. This is because the skull was exposed to the air for some time and the ventricles were fluid-free. In ordinary tomograms the ventricles are not seen.

In Figure 2, certain changes in the shape of structures previously noted are seen. The level is at the canine teeth. The crista galli is fading from view and the cribriform plate is well seen. The supra-orbital sinuses are smaller, and what may be the orifice of this sinus into the ethmoidal air cells is noted on either side. The ethmoid cells are clear and the middle turbinate is seen for the first time. The orbits are smaller and are losing their spherical outline, becoming triangular in shape. The lamina papyracea is no longer clearly seen. The beginning of the superior orbital fissure is just made out in the superior portion of the right orbit.

Both atria are now more triangular than





Figs. 3 and 4. Normal tomograms at level of first molars (3) and at level 6.5 cm. from table top (4).

previously and the walls more closely approximate a straight line. Septa are visualized and the floor of the left infraorbital canal is seen at the apex of the left antrum. The "H" and "R" lines are approaching one another on the left side.

Figure 3 is at the first molar teeth level. The supraorbital sinuses are disappearing. The middle turbinates are in sharp focus, especially on the left side, while the inferior turbinates are being lost to vision. The middle and posterior ethmoidal air cells are well visualized. The orbits are still smaller and more triangular. At this level the extremely thin inferior orbital wall can be seen near the antrum. (The frequent occurrence of interorbital extension of antral cancer thus becomes easily understood.) The superior orbital fissures are coming into clearer detail. The maxillary sinuses show no striking dissimilarity from the previous film. The "H" and "R" lines are still closer on the left side. Tongue substance is seen for the first time.

Descending in the anteroposterior plane to Figure 4, taken at a level which is now 6.5 cm. from the table top, we find that the supraorbital sinus on the left has been completely lost to view and only a small remnant of that on the right side is still seen. The posterior ethmoidal air cells are still clearly demonstrated, and both the middle and inferior turbinates are receding from focus. The orbits are becoming smaller and both superior orbital fissures are now evident. (The inferior orbital fissure is never well seen in anteroposterior tomograms.)

The medial portions of both maxillary sinuses are now elongated from above downward into the maxillary alveolar ridge, and the lateral extensions of the antra into the zygomatic arch are smaller. The "H" and "R" lines have almost approximated one another on the left side. (Both these lines curve abruptly medialward, the "H" line forming the inferior wall of the inferior orbital fissure and the



Figs. 5 and 6. Two cases of chronic sinus infection (Cases 1 and 2).

"R" line forming the superior wall of this same fissure in the skull. Thus they never actually approximate. The relationship of these lines to one another varies in the individual skull. In some they are almost in the same vertical plane, while most frequently the "H" line is somewhat medial to the "R" line.) The molar teeth are now in view.

#### INFECTIONS OF THE ANTRUM

Figure 5 illustrates a case of chronic left maxillary sinusitis (Case 1) in a young man 29 years of age with a history of typical acute exacerbations over a period of eight years.

This film shows a confluent, dense opacity involving all of the left antrum except its extreme apex, the level simulating one of fluid within the cavity of the sinus. In addition, the left ethmoidal air cells are completely obscured by a similar confluent opacity; however, it is seen that

all the walls of the antrum are intact. Also, there is some increase in density of the base of the right antrum. This also assumes a level and is sharply demarcated laterally. It is believed that this represents infectious material trapped in this area and limited by a septum which arises from the inferior aspect of the sinus.

Comparison with the normal tomograms shows this particular film to be at the approximate level of Figure 4. The supraorbital sinuses are just disappearing, as are both the inferior and middle turbinates. The orbits are small and triangular and the posterior ethmoidal sinuses are well delineated. Also the tomogram is at the level of the molar teeth of the maxilla. Tongue substance is not sharply defined. There is a moderate right septal deviation.

Figure 6 represents chronic sinusitis (Case 2) in a young woman 28 years of age with a history of repeated attacks of sinus infection over a period of almost ten years.

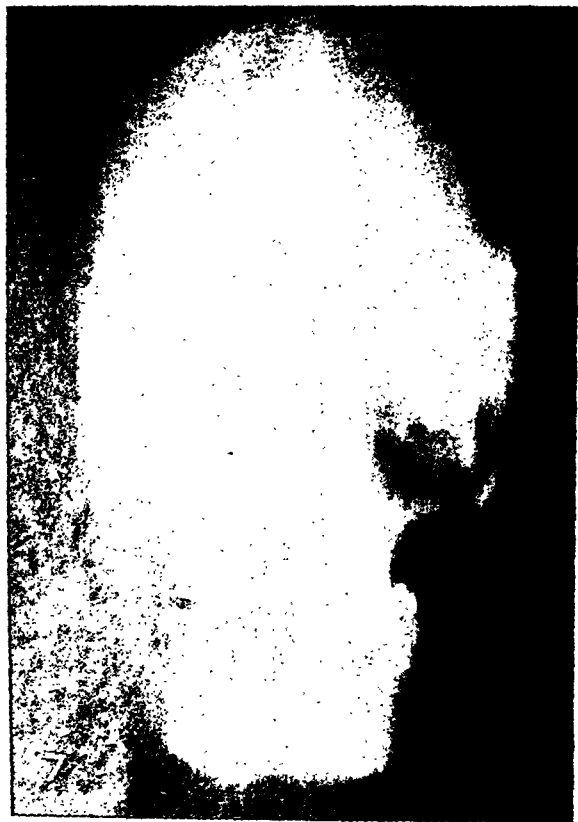


Fig. 7. Cancer of the maxillary sinus (Case 3).

Because of difference in radiologic technic, certain features are not seen in this film as in previous roentgenograms, but it does reveal the extent of infectious disease and is presented for that reason. The orbital walls are just faintly seen. The "R" line is discernible on the left, as is the inferior edge of the "H" line at the base of the left antrum.

The entire right antrum is completely clouded by a rather dense opacity. The base of the left antrum is likewise involved. All antral walls, however, are intact. Edema of both the right inferior and middle turbinates is well shown and the ethmoids are clouded bilaterally, both middle and posterior cells being involved. The level of the tomogram is seen to bisect the maxillary molar teeth bilaterally.

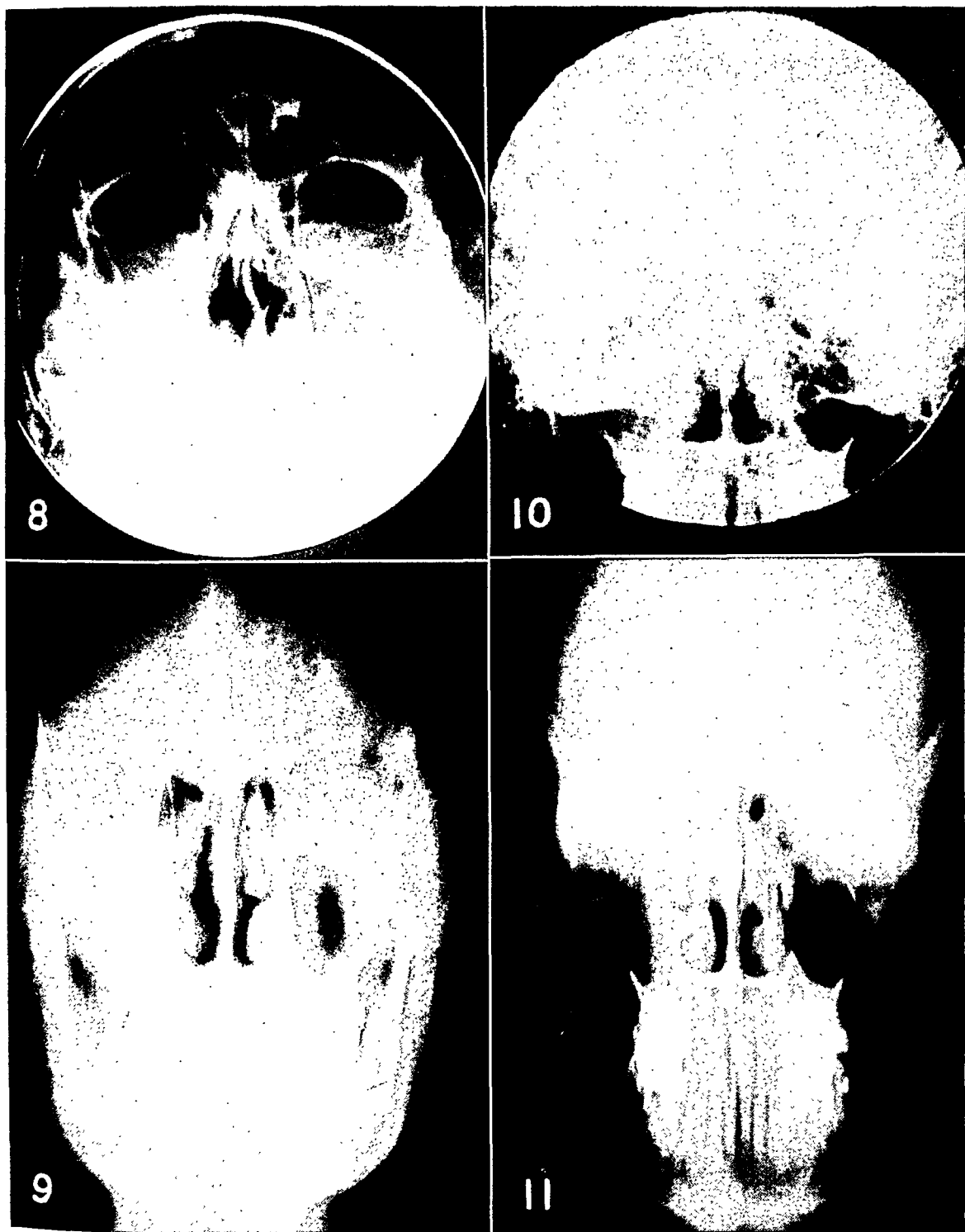
These two cases disclose features which are constant tomographic findings in infectious antral disease. No pathologic disturbances are observed in the limiting walls of these sinuses. They are symmetrically alike, and there is no thinning of

bony structures or actual osseous invasion. Usually a concomitant extension of the disease process to adjoining ethmoidal sinuses is observed and edema of the contiguous turbinates and sometimes of the mucosal wall of the naris is evident. The intact osseous walls of the sinus, however, are most important in the roentgenologic diagnosis.

#### CANCER OF THE MAXILLARY SINUS

Figures 7 to 11 show three cases of antral carcinoma, all involving the right maxillary antrum and all disclosing certain characteristics of cancer in this particular area. Ordinary roentgenograms of the last two cases are presented to illustrate the value of the tomogram in revealing detail not apparent in the ordinary films.

Figure 7 is one of extensive carcinoma (Case 3) in a man 69 years of age with right exophthalmos, disturbed vision, and complete blockage of the right naris. In this film, the level is at the maxillary teeth bilaterally. A dense opacity involves the entire right antrum. The inferior antral wall clearly shows destruction. There is no evidence of remaining medial antral wall, and the soft-tissue density overlies this area and completely obliterates the right nasal cavity. Superiorly, there are destruction of the inferior orbital wall and extension of the process within the orbit itself. This tomogram shows all but the superior wall of the right orbit to be clouded by the density. The opacity extends medially and upward to involve both the middle and posterior ethmoids, a frequent occurrence. The "H" and "R" lines are obscured on the right but are well delineated on the left side of the skull. There is slight cloudiness, probably infectious in nature, of the left antrum. There are moderate edema of the left middle and inferior turbinates and slight cloudiness of the middle and, to a lesser degree, of the posterior ethmoidal air cells on the left. The turbinates are not seen on the affected side. The left orbit is small and triangular. Tongue substance is well shown, as in the normal tomogram.



Figs. 8-11. Two cases of carcinoma of the maxillary sinus (Cases 4 and 5). The ordinary roentgenograms are shown above, the corresponding tomograms below.

Loss of visualization of the "H" and "R" lines does not represent invasion by cancer but rather an obscuring of these

structures by overlying tumor and edematous soft tissue.

Figure 8 is the ordinary roentgenogram

of Case 4, a squamous carcinoma involving the right antrum in a man 50 years of age. There is a density within the right antrum which almost completely fills the chamber. The lateral and medial antral walls, however, appear intact, and the inferior wall of the sinus is obscured by bony structures in the same plane. There is no definite evidence of ethmoidal invasion, although some cloudiness is apparent within the cells. The orbital walls are intact.

The tomogram (Fig. 9) in this case, however, reveals a dense opacity completely clouding the right antrum. There is an area of bone destruction of the inferior antral wall and also of the lateral sinus wall. This cloudiness does not involve the orbit but extends superiorly and medially and to a small extent involves the middle ethmoidal air cells. The lateral and inferior walls of the right antrum are very thin, due to cancerous invasion and destruction. The nasal cavities show no abnormalities. There is a slight cloudiness of the lateral portion of the left antrum. Both orbits are well seen and still are spherical in outline, although rather small. The posterior ethmoids are clear. The "H" line is seen at the very base of the left antrum and the "R" line is well shown. Neither of these lines is well seen on the left side. The level of these films extends through the maxillary molar teeth bilaterally. The ascending rami of both mandibles are well delineated on this film, and the condyloid process is visible on the left side.

Figure 10 (Case 5) is an ordinary roentgenogram of a 47-year-old male who complained of right nasal blockage and pain in the right eye. The film discloses a moderate density involving the entire right antrum. There is a bulging soft-tissue mass obstructing the right naris, arising from the lateral wall of the nasal chamber, although there is no evidence of destruction of this medial antral wall. All the walls of the right antrum appear to be intact, and there is no evidence of inferior orbital wall destruction on either side. The ethmoidal sinuses are slightly clouded, and both

medial and inferior turbinates are enlarged. Biopsy from the right maxillary sinus disclosed squamous carcinoma.

The tomogram (Fig. 11) in this case gives us much more detailed information. A dense opacity involves the medial half of the right antrum and indicates destruction of the right medial sinus wall. The process obstructs the superior portion of the nasal cavity and involves both the middle and posterior ethmoid cells. There is a suggestion of destruction of the inferior orbital wall on the affected side. Both orbits are well seen and the inferior turbinates appear slightly edematous. The left middle turbinate is clearly outlined and edematous, and only the inferior portion of the right middle turbinate is seen. The left antrum is intact and shows no evidence of abnormality. The tomogram is at the level of the molar teeth of the maxillae bilaterally, but no tongue substance is delineated. The "H" and "R" lines are not clear on this film.

These three cases of antral carcinoma reveal certain characteristic tomographic findings which are worth noting. It is also noteworthy that ordinary roentgenograms fail to picture the entire pathologic process which is so well delineated by tomographic means. Patients with antral carcinoma consult their physicians for one or more of three symptoms: nasal obstruction, visual disturbance, or pain. If these signs do not disappear under active medical therapy in a reasonable period of time, the patient should have tomographic studies and a biopsy if the roentgenograms suggest that carcinoma may be present.

As seen in the three cases, carcinomatous invasion and destruction of one or more of the antral walls is a frequent finding and may occur comparatively early in the disease. In most cases, the soft tissue tumor shadow extends beyond the antrum itself, through its osseous limits to adjacent structures, *i.e.*, naris, orbit, and oral cavity. It is only rarely that antral carcinoma is observed prior to osseous invasion or destruction and it is usually the symptoms caused subsequent to such de-

struction by the expanding mass of the tumor that force the patient to seek medical advice.

#### SUMMARY

Chronological adjacent tomograms through the levels of the mid-portion of the maxillary sinuses of an adult cadaver are presented, and the normal anatomical structures are described.

Comparison of these films is made with several tomograms disclosing infection and cancer in this area.

The tomograms in the cases of infections of the antrum disclose the following characteristics: (1) Pathologic disturbances in the limiting walls of the sinus are rare and the outline of both chambers is symmetrically alike. (2) Extension of the disease process to adjoining ethmoid sinuses is usually observed. (3) Edema of the contiguous turbinates and nasal mucosa is a constant finding.

Tomography in cancer of the antrum invariably discloses invasion and destruction of one or more of the walls of the sinus; also, the soft tissue shadow of the expanding tumor extends beyond the osseous limits of the sinus, invading adjacent structures, *i.e.*, naris, orbit, and oral cavity. Ethmoid sinus invasion is frequently seen.

Ordinary roentgenograms in cases of cancer of the maxillary sinus do not reveal these abnormalities so clearly or so fully as

do tomographic films. The former frequently fail to disclose cancerous invasion of the limiting walls of the antrum.

It is the opinion of the authors that tomographic study is indicated in those cases in which clinical signs and ordinary roentgenograms suggest the presence of cancer in this area.

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#### BIBLIOGRAPHY

1. LEBORGNE, F.: Tomography, cancer laringo-tomographia. Montevideo, K. Garcia Morales, 1938.
2. LEBORGNE, F.: Laryngeal Tomography. *An. de oto-rino-laring. d. Uruguay* 8: 169-187, 1938.
3. LEBORGNE, F.: Tomography and Cancer of the Larynx. *Arch. Otolaryng.* 31: 419-425, 1940.
4. CAULK, R. M.: Tomography of the Larynx. *Am. J. Roentgenol.* 46: 1-10, 1941.
5. MOORE, SHERWOOD: Body Section Roentgenography with the Laminagraph. *Am. J. Roentgenol.* 39: 514-522, 1938.
6. MOORE, SHERWOOD: Practical Applications of Body Section Roentgenography. *Am. J. Roentgenol.* 44: 24-30, 1940.
7. MOORE, SHERWOOD: Body Section Radiography in Surgical Conditions. *Am. J. Surg.* 46: 309-316, 1939.
8. COSTEN, J. B.: Correlation of X-Ray Findings in Mandibular Joint with Clinical Signs, Especially Trismus. *J. Am. Dent. A.* 26: 405-407, 1939.
9. PEYRUS AND AUBERT: Stratigraphy in Examination of the Temporo-Mandibular Joint. *Rev. de stomatol.* 40: 155-159, 1938.
10. PIPPIN, MOORE, McCULLOUGH, AND MOORE: Method of Repositioning the Mandible in Treatment of Lesions of the Temporo-Mandibular Joint. *Washington University Dent. J.* 6: 107, 1940.
11. CONE, A. J., MOORE, S., AND DEAN, L. W.: Relationship of Paranasal Sinus Disease to Ocular Disorders: New Critical Method of Investigation by Laminagraphs. *Laryngoscope* 49: 374-393, 1939.
12. EPSTEIN, B. S.: Skull Laminagraphy. *Radiology* 38: 22-29, 1942.



# Some Roentgen Aspects of Pancreatic Necrosis<sup>1</sup>

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THE CLINICAL diagnosis of acute pancreatitis is made rather infrequently; yet the diagnosis following surgical exploration is not uncommon. This wide discrepancy attests our lack of acumen in establishing a correct evaluation of those cases studied. Hence, any means that will provide a clearer understanding must command attention.

A large group of cases has been studied roentgenographically over a period of years, and various signs indicative of acute or subacute pancreatitis have been enumerated. These point predominantly to the changes induced in the gastro-intestinal tract, especially the stomach and duodenum. Case (1) in his excellent treatise on the subject reviews the changes that may be manifest, but it is evident that no one of these or any combination is diagnostic, nor will we, in this discussion, contribute any definitive set of criteria by which a positive roentgen diagnosis can be achieved. The case under discussion was, however, characterized by such striking roentgenographic findings that we feel they should be recorded.

One of the most significant reasons for the many incorrect diagnoses is the failure to think of the pancreas as the basis of abdominal complaints. A greater awareness of the organ as the exciting factor of abdominal symptoms will undoubtedly lead to closer scrutiny prior to exploratory laparotomy and contribute to more accurate diagnosis.

Bronner (2) suggests upper intestinal studies in any suspicious case, so that changes in the position, contour, and physiology of the stomach and duodenum may be demonstrated. Frostberg (3) attached considerable significance to the

"inverted figure 3 sign" in changes within the head of the pancreas. We have encountered this particular sign infrequently, even though a number of cases of carcinoma of the pancreas were studied very carefully. We did, however, find it present in one instance, and on the strength of it, plus spasm of the duodenum, we proffered the diagnosis of pancreatitis. This was verified at operation.

In the case to be recorded here the signs and symptoms pointed so strongly to disease of the large intestine that no opaque material was given by mouth. Instead, a barium enema was considered the most logical procedure, after a film of the abdomen had been made. Unfortunately, the film failed to include the lung bases, so that we were deprived of the value of one finding that has been stressed—the basal exudates that often occur. The latter are mentioned by de Takáts and Mackenzie (4) and by Case (1) as an important part of the roentgen pattern in pancreatitis.

## CASE REPORT WITH NECROPSY FINDINGS

W. E. S., a 42-year-old white married male, a cotton-mill worker, was admitted to the medical service for the first time on June 7, 1943, complaining of abdominal pain and distention of ten days' duration. He had previously been admitted to the surgical service, in January 1943, with a recurrent thrombophlebitis of the left leg, which was treated conservatively and successfully.

The illness for which the patient was admitted to the medical service had begun about ten days previously, at which time he experienced some vague abdominal discomfort and had an intense desire for large quantities of ice water and food. Shortly thereafter he noticed a rather diffuse abdominal swelling followed by generalized cramping abdominal pain, especially in the lower abdomen. This pain became severe and kept him moving constantly in an effort to obtain relief. He finally called his local physician, who gave him hypodermics, but the pain was only temporarily relieved. About twelve hours after the onset of symptoms, the patient became nauseated and vomited. The vomitus was greenish and bitter

<sup>1</sup> From the Departments of Radiology and Medicine, Duke University School of Medicine, Durham, N. C. Accepted for publication in October 1943.

and measured about a pint in quantity. On only two other occasions did vomiting occur before admission. The patient still had a desire for food, but had been afraid to eat because it seemed to accentuate the pain and distention. Belching was frequent and seemed to afford some relief. However, little or no flatus was passed and the patient stated that he had not had a bowel movement during the ten days of his illness. His last normal bowel movement was on the day prior to the onset of symptoms. He was given repeated enemas in his home and also at a local hospital, but without results; nor did they afford him any relief. A note from a local physician stated that the patient had had several episodes of this character during the previous two or three years, but in the review of symptoms and past history obtained at the hospital in January, six months before the patient's final illness, no mention of such attacks was made.

The family history was positive for cancer, diabetes, and tuberculosis. The patient had enjoyed unusually good health with the exception of the thrombophlebitis mentioned above. He said that he had lost approximately twenty pounds during his illness.

*Physical Examination:* The patient was well developed and well nourished and obviously acutely ill. His temperature was 38.2° C., pulse 122, respirations 24, blood pressure 126/84. During the examination he complained constantly of abdominal pain and was made quite uncomfortable by any effort to move him. Except for evidence of dehydration, the skin was not remarkable. Examination of the head and neck was negative. The thorax was symmetrical, but there was some flare of the lower costal angles, apparently due to abdominal distention. The lung fields were clear to auscultation and percussion, but the diaphragm was somewhat high. Examination of the heart was within normal limits except for tachycardia. The abdomen was rounded and protuberant, and the abdominal wall was tense and tympanitic. There was generalized tenderness in all abdominal quadrants and moderate rebound tenderness in both lower quadrants. It was thought, in spite of the marked distention, that the liver was considerably enlarged, but no other visceral detail could be outlined and no abnormal masses were felt. The superficial veins of the abdominal wall stood out in striking prominence. Large hard masses of feces could be felt by rectal examination. The genitalia were not remarkable. Examination of the extremities revealed no evidence of clubbing, cyanosis, edema, or phlebitis. Neurological examination was in order.

*Preliminary Clinical Impression:* 1. Obstruction of the large bowel. 2. Portal obstruction, possibly on the basis of cirrhosis of liver.

Accessory clinical data were as follows: Hemoglobin 11.3 gm., or 73 per cent. Red blood cells 4,410,000. Color index 0.82. Hematocrit reading 38.2 vols. per cent. White cells 12,280 (polymorpho-

nuclears 94, large lymphocytes 1, small lymphocytes 2, monocytes 3). Sedimentation rate 36 mm./hr. corrected. Urine, on admission, clear amber; sp. gr. 1.016; acid reaction; sugar a trace; albumin 1 +; microscopic sediment, 3-4 granular casts, 6-7 white blood cells (?) per high-power field; acetone 4 +; diacetic acid negative. Kahn and Klein tests negative. Stools not remarkable except for 1 + benzidine reaction after ether extraction. Blood chemistry: non-protein nitrogen 44 mg. per 100 c.c. Liver function test (BSP): 5 per cent retention of dye after one hour. Galactose tolerance test within normal limits.

*Roentgen Findings:* A plain film of the abdomen showed no definitive visceral detail, but there was present a mottled process characterized by irregular rounded areas of increased density. These areas ranged from 1.0 to 3.0 cm. in diameter and showed no calcification. A film with a stomach tube in place showed the tube deflected well to the right and upward.

A barium enema study revealed areas of spasm associated with loss of normal mucosal detail. These areas were in the mid-transverse colon, the splenic flexure, and the ileocecal region. There was no evidence that any intrinsic lesion was present.

*Hospital Course:* The patient was given nothing by mouth and parenteral administration of fluids was begun. A Wangenstein apparatus was installed and surgical consultation was obtained immediately. The surgical consultant expressed the belief that the patient had a fecal impaction and advised thorough cleansing of the lower bowel with repeated enemas, before anything else was done. This was carried out with good results and considerable relief to the patient. He had a fairly good first night in the hospital, and the next morning it was thought that there was less abdominal distention. The liver was palpable about 2 cm. below the right costal margin, but no other masses could be made out. At this time a barium enema was given and the results were as recorded above. The patient remained fairly comfortable throughout the next twenty-four hours, without any temperature elevation. On the night of the second hospital day he had a normal bowel movement. He awoke on the third hospital morning complaining of generalized increase in abdominal pain, which seemed to become progressively worse from that time. The abdominal distention returned but there was still no nausea or vomiting; there was generalized abdominal tenderness with rebound tenderness in all quadrants, but there were no referred rebound phenomena. No intestinal patterns could be made out. For the next two days the patient gradually grew worse, his temperature going to 39° and his pulse to 140. On the sixth hospital day abdominal tenderness and distention increased and, because of signs consistent with the presence of free fluid in the peritoneal cavity, an abdominal paracentesis was performed. Only 2 c.c. of dark amber fluid were obtained, but



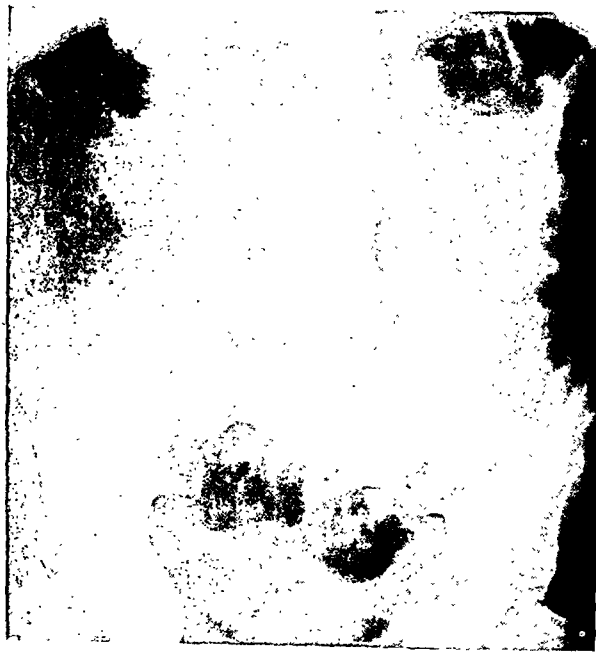


Fig. 1. Film of abdomen showing diffuse mottled appearance. The gas-filled colon shows irregularity about the cecum and the transverse colon.



Fig. 2. The striking displacement of the stomach tube is evident, as well as the diffuse mottling over the abdomen.

this material showed a total leukocyte count of 1,120, with 61 per cent polymorphonuclear forms, and gave a strongly positive benzidine reaction. Culture of this fluid was later reported as negative. A few hours later, the patient presented the picture of peripheral vascular collapse, and after transfusions of whole blood and plasma it was decided to do an exploratory laparotomy.

The patient was obviously a poor operative risk, but there seemed to be no alternative. He was given gas, oxygen, and ether anesthesia, which he took poorly. When the extraperitoneal fat layer was reached, extensive areas of fat necrosis were encountered. In the peritoneal cavity, a moderate amount of blood-tinged fluid was found and aspirated. Manual exploration of the abdominal cavity revealed a large, firm mass in the region of the pancreas, extending all the way across the upper abdomen and measuring approximately  $10 \times 20$  cm. The omentum, peritoneum, mesentery, and intestinal surfaces were studded with numerous areas of firm white material which resembled fat necrosis. No purulent material could be aspirated from the pancreas. The incision was closed after drains were inserted and the patient was returned to the ward in poor condition.

The postoperative course was stormy. The temperature remained above  $40^{\circ}$  and there was continuous vomiting of "coffee-ground" material. On the third postoperative day the patient vomited about 500 c.c. of fresh blood. He died on the following day.

Accessory data obtained throughout the postoperative course were as follows: Hemoglobin 68 per

cent. White blood cells 13,640. Blood sugar 110 mg. per cent. Van den Bergh reaction not elevated. Serum calcium 6.8 mg. per cent. Urinary diastase less than 150 units. Serum lipase 2.3 c.c. NaOH (1/20th normal).

*Autopsy Findings:* The external appearance of the body at autopsy was not particularly significant. There was pitting edema of the entire left leg, but not of the right.

Examination of the abdominal cavity was quite remarkable. The subcutaneous fat of the abdominal wall measured 1.5 cm. in thickness. In the abdominal cavity about 400 c.c. of grayish-brown fecal-smelling fluid were encountered. After removing the fluid the intestines were found to be everywhere adherent along their adjacent peritoneal surfaces. Scattered diffusely throughout the parietal peritoneum were numerous flat, whitish-yellow, firm nodules. These were present also in the peritoneal surfaces of the intestines, in the mesentery, and throughout the omentum. Many of these plaques were surrounded by areas of fresh hemorrhage. The remaining peritoneal surfaces were cloudy but smooth. The transverse colon and stomach were shifted to abnormal positions by the lesser omental bursa, which was distended with fluid, the colon being pushed anteriorly and inferiorly, the stomach superiorly and to the right. The foramen of Winslow was closed by a grayish, dark mottled membranous adhesion with a small defect at one side. Pressure over the bursa forced out a grayish-brown, foul-smelling fluid containing many small soapy granules. Numerous fibrous adhesions were found in the pelvis, which also contained the yellowish-white

plaques. Sectioning of the plaques showed them to be firm but not calcified. Many extended deeply into the fatty areas; some had formed large confluent areas, while others were necrotic and milky.

The mesentery was greatly increased in size and loaded down with fat. Large redundant folds of fat were found throughout the mesentery of the large bowel. Everywhere were yellowish-white plaques of fat necrosis, many surrounded by hemorrhage.

As stated above, the stomach was pushed upward and to the right by the fluid-distended omental bursa. The position, size, and shape of the stomach were greatly distorted and undoubtedly accounted for the anatomical relations demonstrated roentgenologically. The stomach contained about 100 c.c. of coffee-ground material and near the cardiac end was an area of mucosal hemorrhage which apparently accounted for the blood vomited post-operatively.

The pancreas was identified in its usual position as a large, ragged, grayish-black, necrotic mass, forming one border of the fluid-filled sac. Gross sectioning showed the inner structure to be obscured by areas of necrotic softening and hemorrhage. The main pancreatic duct opened about 3 cm. from the duodenum into the omental cavity already described. The ampulla of Vater was patent, as were the common, cystic, and liver bile ducts. These were not dilated. No calculi were found.

The gallbladder contained about 10 c.c. of dark, thick, orange-colored bile, but no calculi were found. The gallbladder wall was considerably thickened both by serosal fibrosis and mucosal cholesterosis. The liver was moderately enlarged, weighing 1,500 gm. Its cut surface gave the appearance of increased fat. The adrenals and genito-urinary tract were not grossly remarkable.

The pleural cavities contained small amounts of serosanguineous fluid, but the pleural surfaces were smooth. The subpleural fat contained many areas of hemorrhagic fat necrosis, most of which were perivascular in position. The heart was normal in size and appearance. The coronary arteries were not remarkable. The lungs on cut surface showed evidence of some bronchial pneumonia.

Microscopic sections were equally as characteristic of an acute hemorrhagic pancreatitis as the gross manifestations. The pancreas presented a pronounced degree of atrophy, marked dilatation of the ducts, and an accompanying hyperplasia and keratinization of the duct epithelium. In some places, the latter lesion was of such a nature as to obstruct completely the lumen of the duct. Although hemorrhage was prominent, the necrosis of the tissue was a far more conspicuous feature. Fat necrosis was present in numerous places and crystallization of the fatty acids was also seen in some of these lesions. There were, however, no calcium deposits in these areas of fat necrosis.

The gallbladder showed a very definite chronic



Fig. 3. Showing changes at the medial wall of the splenic flexure of the mid-transverse colon and also at the ileocecal region.

cholecystitis and also acute reaction of its serosal surface. There was an overwhelming infection of the tissues of the body, generally, the most conspicuous organism being *E. coli*. This organism was grown in cultures taken from the spleen, lung, and peritoneal fluid at the time of autopsy.

#### DISCUSSION

The roentgen findings were interesting and permitted considerable speculative latitude as to the underlying condition. An appreciation of the extensive changes that occur with fat necrosis incident to pancreatitis led to the assumption that the mottled areas of increased density actually represented fat necrosis and subsequent saponification, which is so characteristic pathologically (Fig. 1).

The marked displacement of the stomach to the right and upward (Fig. 2), we interpreted as due either to swelling of the pancreas and surrounding inflammatory tissue or a sealing-off of the foramen of Winslow with subsequent accumulation of fluid within the lesser omental bursa.

The barium enema revealed three zones (Fig. 3) of disturbance in the colon. There was persistent spasm with alteration of the mucosal pattern of the transverse colon and the splenic flexure. The close

anatomical relationship between the pancreas and the involved areas of the colon made it reasonable to assume that pancreatic involvement was the source of these changes. The enema film likewise showed marked changes about the cecum and terminal ileum and these were deemed as secondary to the fat necrosis and the incident peri-intestinal inflammation.

All the changes described may, of course, be readily explained on the basis of a peritonitis pursuant to a ruptured viscus. The absence of any free air in the abdomen was against such a diagnosis; moreover, an appraisal of the clinical course made it the less likely condition.

#### CONCLUSIONS

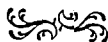
A case of hemorrhagic pancreatitis with extensive fat necrosis is presented. The

roentgen features were: (1) a mottled increase in density over the abdomen; (2) displacement of the stomach to the right and upward; (3) areas of spasm in the mid-transverse colon, the splenic flexure, and the ileocecal region.

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#### REFERENCES

1. CASE, JAMES T.: Roentgenology of Pancreatic Disease. *Am. J. Roentgenol.* 44: 485-518, October 1940.
2. BRONNER, H.: Roentgen Diagnosis of Acute Pancreatitis. *Zentralbl. f. Chir.* 55: 2436-2440, Sept. 29, 1928.
3. FROSTBERG, N.: Characteristic Duodenal Deformity in Cases of Different Kinds of Peri-Vaterial Enlargement of the Pancreas. *Acta radiol.* 19: 164-173, 1938.
4. DE TAKÁTS, G., AND MACKENZIE, W. D.: Acute Pancreatic Necrosis and Its Sequelae: Critical Study of 30 Cases. *Ann. Surg.* 96: 418-440, September 1932.



# Reciprocity Law Failure in X-Ray Films<sup>1</sup>

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THE RECIPROCITY law constitutes one of the fundamental rules of photography and of radiography. It states that the quality of a series of photographic or radiographic films will be uniformly constant if the exposure times with which the films are made vary reciprocally with the intensities of the exposing radiation. Thus, the law implies that when other things are equal a roentgenogram exposed for 1.0 second and with a tube-current of 100 milliamperes will be identical to one exposed for 10 seconds and with a tube-current of 10 milliamperes.<sup>2</sup>

The reciprocity law is based on the assumption that the density or blackening of a photographic film is dependent merely on the exposure or quantity of radiant energy which the film absorbs and is independent of the rate at which the energy is applied (*i.e.*, is independent of the intensity of the exposing radiation). The significance of this assumption will be clearly understood when it is pointed out that the exposure or quantity of radiant energy absorbed by a film is equal to the product of the radiation's intensity by the exposure time; that is,

$$\text{Exposure} = \text{Intensity} \times \text{Time} \quad (1)$$

It is evident from equation (1) that, when intensity and time vary reciprocally, exposure remains constant. Therefore, the reciprocity law can be valid only when photographic density is dependent on exposure alone.

The reciprocity law was formulated from observations made by Bunsen and Roscoe (1) almost a century ago, when

those workers were studying the phenomena of photochemistry. Although the law was intended to apply to photochemical reactions in general, it had, from the outset, its principal application in photography, where it was used extensively as an aid in the calculation of exposure technics. Its usefulness in this connection, however, was soon found to be somewhat limited, for further investigations revealed that photographic films fulfill the law only under limited conditions. For example, astronomers (2, 3), when photographing stellar objects of extremely low illumination, observed that much smaller photographic effects were obtained under these conditions than when exposures were made with higher intensities, even though the products of intensity by exposure time in the two instances were equal. Similarly, it was observed by other investigators (4, 5) that, when exposures were made with radiation of extremely high intensity, the effects were less than those obtained when a more intermediate level of intensity was employed. It is clear from these observations that, contrary to the provisions set forth in the reciprocity law, photographic quality is not merely dependent on the quantity of radiant energy absorbed by a film, but is also a function of the intensity of the exposing radiation. This property of photographic materials to violate the reciprocity law is customarily spoken of as reciprocity law failure.

The principal significance of reciprocity law failure is its effect on the sensitivity or speed of a photographic emulsion. Because more radiant energy is required to produce a particular photographic effect at some intensity levels than at others, it is evident that the sensitivity or speed of a film must vary with the intensity of the exposing radiation.

<sup>1</sup> The work described in this paper was done under a contract, recommended by the Committee on Medical Research, between the Office of Scientific Research and Development and the University of Chicago. Accepted for publication in November 1943.

<sup>2</sup> It is assumed that the intensity of the radiation is proportional to the current of the x-ray tube.

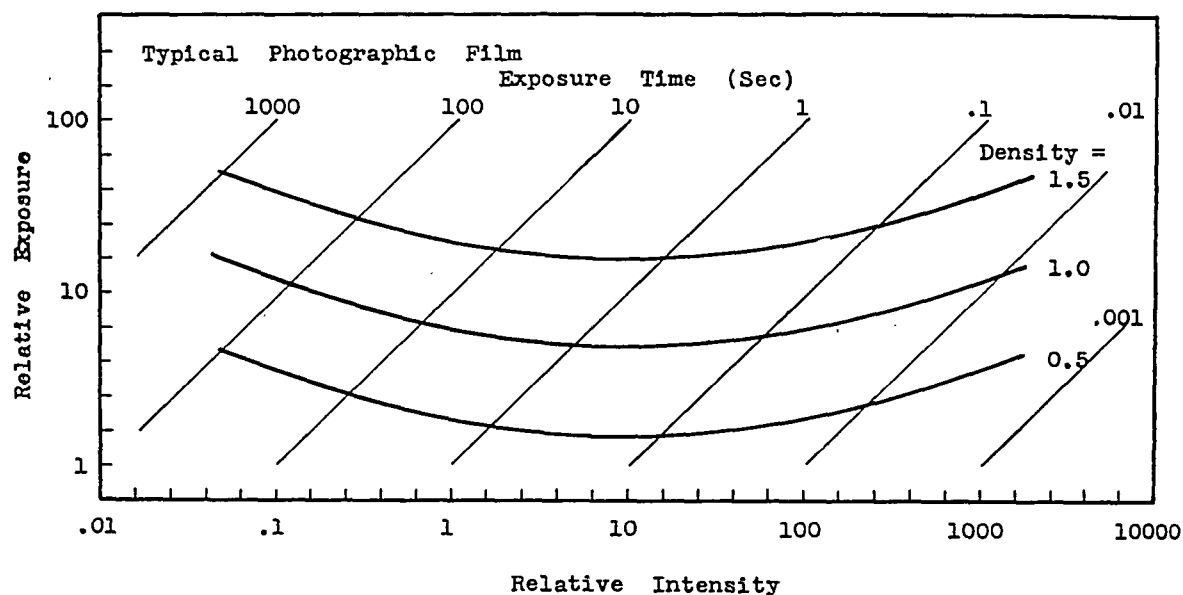


Fig. 1. Curves illustrating reciprocity law failure in a typical photographic film. The exposures required to produce film densities of 0.5, 1.0, and 1.5 at various levels of intensity are shown. The diagonal lines indicate the exposure times which correspond to the various intensity levels.

Although photographic films vary widely in the manner in which they fail the reciprocity law, there are certain general characteristics that are common to all:

1. Photographic emulsions are least sensitive when exposed with radiation of either low or high intensity and are most sensitive when the intensity of the exposing radiation is such that an exposure time between 0.1 second and 10 seconds is required to produce a film density of 1.0 (6, 7).

2. Within the visible spectrum, reciprocity law failure is independent of the spectral distribution of the exposing radiation (8).

3. The inherent contrast of a photographic emulsion is a function of reciprocity law failure. It is greatest when exposures are made with intensities less than that at which maximum film sensitivity occurs (9).

#### METHODS OF STUDYING RECIPROCITY FAILURE

During the past several decades extensive data have been collected on the reciprocity-law-failure characteristics of many photographic films, and several

workers (3, 7, 10) have devised empirical formulae intended to be useful in predicting the density (photographic effect) of a film when exposed with a particular quantity of radiant energy at various intensity levels. These formulae, however, have proved of little practical value, due to the wide variation in the characteristics of different photographic materials. Of greater usefulness are graphical data prepared from sensitometric examinations of a film exposed under various conditions of illumination. In the past, three methods have been employed in the preparation of such material. In one, the photographic film is given a series of constant-energy exposures in which the intensity and exposure time are varied reciprocally (e.g.,  $I \times t = 100 \times 1, 10 \times 10, 1 \times 100$ , etc.). The film is processed and the several densities are measured. Density is then plotted against intensity of exposing radiation. Another method, proposed by Arens and Eggert (11), consists in determining sensitometrically the exposure times required to produce a particular film density (e.g., a density = 1.0) at various intensity levels. Exposure time is then plotted as a function of radiation intensity. In the third method, suggested by Kron (7) and

later expanded by Jones and Webb (9), the exposures ( $I \times t$ ) required to produce a constant density are determined sensitometrically under various intensity conditions. As in the other methods, results are expressed in graphic form.

A family of curves obtained by the third method and illustrating the exposures required to produce three different densities in a typical photographic film at various levels of intensity are shown in Figure 1. If the reciprocity law were valid, these curves would be horizontal straight lines, since fulfillment of the law implies that the blackening of a film is independent of the intensity of the exposing radiation. That they are not is graphic evidence of the existence of reciprocity law failure. The general shape of these curves is characteristic of all photographic emulsions when exposed with radiation within the visible spectrum. It will be observed that there is one intensity level at which a minimal amount of exposure is required to produce a particular density. This intensity is frequently called the optimal intensity, or the intensity of maximum film sensitivity. Its value changes from one emulsion to another but, as previously stated, it usually is such that the exposure time required to produce a density of 1.0 falls between 0.1 and 10 seconds. The diagonal lines in Figure 1 indicate the exposure times which correspond to the various intensity levels.

Much useful information, including the speed, contrast, and other characteristics of a film, may be obtained from curves similar to these. For example, the speed or sensitivity of a radiographic film is customarily derived from the equation,

$$s_e = \frac{d}{E_{1.0}} \quad (2)$$

where  $s_e$  is the speed of the film,  $E_{1.0}$  is the exposure ( $I \times t$ ) required to produce a film density of 1.0, and  $d$  is an arbitrary constant of such magnitude that the various values of  $s_e$  fall within a convenient range of numbers. The values of  $E_{1.0}$  may be determined directly from the experimental curves.

#### RECIPROCITY LAW FAILURE IN X-RAY FILM

Although photographic materials have been thoroughly investigated for reciprocity law failure, relatively few studies have been made on radiographic film, for reasons that will presently become apparent.

The sensitivity of a photosensitive emulsion is a function of the quality of the exposing radiation. Accordingly, when a film is investigated for reciprocity law failure, either the intensity of the exposing radiation must be recorded by an intensitometer whose spectral sensitivity is identical with that of the film under test, or the quality of the radiation must be maintained constant through the complete range of intensity studied. Until recently no x-ray intensitometer fulfilled the first criterion, and except under limited conditions it is most difficult to fulfill the second. If the intensity is varied by changing the target-film distance, the filtration of the intervening air may cause significant changes in x-ray quality. Also, if intensity is regulated by changes in the milliamperage applied to the x-ray tube, alteration in the wave-form of the potential produced by the x-ray transformer-rectifier system will be sufficient to cause important changes in quality unless a constant-potential machine is employed.

In spite of these difficulties, limited studies<sup>3</sup> of reciprocity law failure in films exposed to x-rays directly have been conducted by several workers (12-17). All reached the conclusion that emulsions exposed in this manner fulfill the reciprocity law. These observations have been supported by Holthusen and Hamann (18) and by Rosenberger, and Goldhaber (19), who studied reciprocity law failure in films exposed with gamma radi-

<sup>3</sup> As early as 1899, Precht (12) observed that films exposed with x-rays do not behave as films exposed with light. It was not until later, however, that organized studies of this phenomenon were instituted. The first quantitative data to indicate that films exposed with x-rays directly obey the reciprocity law were reported by Kroncke (13), whose observations were carried out through an intensity range of one to four. Later investigations expanded the range to over one to one hundred.

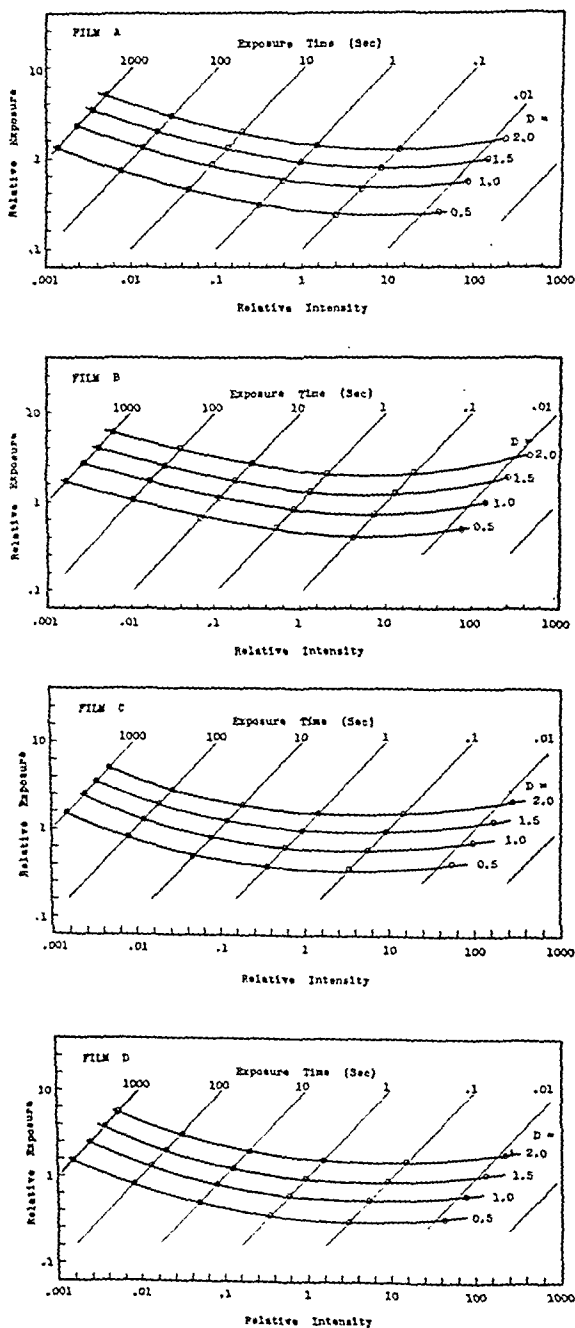


Fig. 2. Curves illustrating reciprocity law failure in four brands of x-ray film exposed with intensifying screens.

ation; in these latter investigations, no failure was observed through a range of intensity exceeding one to ten thousand.

As far as can be determined, no studies have been made on the reciprocity-law-failure characteristics of films exposed with intensifying screens. Since 90 to 98 per cent of the density in such films is produced by fluorescent radiation in the visible

spectrum, it is reasonable to expect that they will exhibit characteristics similar to those of photographic emulsions.

The major difficulties involved in the study of reciprocity law failure in radiographic film have recently been overcome by the development of an x-ray intensitometer (20) whose spectral sensitivity may be made to parallel those of films exposed either with or without intensifying screens through an extensive range of x-ray quality.<sup>4</sup> With the aid of this instrument, the reciprocity-law-failure characteristics of four brands of radiographic film exposed with and without intensifying screens have been investigated in this laboratory.

In the investigation the films were examined sensitometrically by the aluminum-ladder method proposed by White (21). In the case of the exposures made with intensifying screens, the range of intensity studied was one to one hundred thousand; the range of intensity employed in the exposures made with x-rays directly was one to ten thousand. Radiation was supplied by a four-valve full-wave (60-cycle) generator for exposures of ten seconds or less, while a generator utilizing a Villard circuit provided the radiation for the exposures of longer duration. Radiation intensity was measured by the x-ray intensitometer referred to above, but modified to operate as an integrating device to facilitate its use when exposure times were less than one second. The half-value layer of the radiation employed in the intensifying screen exposures was held constant within  $\pm 10$  per cent, in order to maintain the relative contributions to film blackening by the front and back intensifying screens constant throughout the investigation. This was done to insure that the shape of the films' sensi-

<sup>4</sup> Strictly speaking, the spectral response of this intensitometer does not coincide with that of any radiographic film. When the exposing radiation is heterogeneous, however, the instrument's response has been found to parallel that of films exposed either with or without intensifying screens through a wide range of x-ray quality when the proper adjustments are made. Thus the intensitometer effectively fulfills the criterion that its spectral response be identical to that of the film under test.

tometric curves be consistently uniform. The various films were processed under identical conditions in a pictol-hydroquinone developer and finally were subjected to densitometric examination.

It is well established that reciprocity law failure is affected to a considerable degree by changes in room temperature (22). During the investigation, the temperature of the exposing room remained within  $\pm 3^\circ$  of  $25^\circ$  C., a variation that is not likely to cause significant error in the experimental results.

The results of the investigation are shown graphically in Figures 2 and 3, in which the exposures required to produce densities of 0.5, 1.0, 1.5, and 2.0 in each of the four brands of film are plotted as a function of the intensity of the exposing radiation. For Figure 2, exposures were made with intensifying screens, whereas, for Figure 3, the films were exposed to roentgen rays directly. The diagonal lines indicate the exposure times employed at the various intensity levels. All of the films from which the data recorded in Figure 2 were derived were exposed with Eastman ultra-speed intensifying screens. Curves, identical in form, were obtained with other brands of screens; in each case, however, the curves were displaced in a direction parallel to the exposure-time diagonals, a distance depending on the screen's intensification factor.

It is interesting to observe that the curves of the films exposed with intensifying screens (Figure 2) are similar in form to those of the photographic film illustrated in Figure 1. This clearly indicates that films exposed in this manner fail the reciprocity law in much the same way as do photographic materials. As previously pointed out, this is as one would expect, for almost all of the blackening in films exposed in this manner is produced by fluorescent radiation falling within the visible spectrum.

Films exposed with x-rays directly behave in a remarkably different manner. Since the curves, illustrated in Figure 3, are horizontal straight lines, it is evident

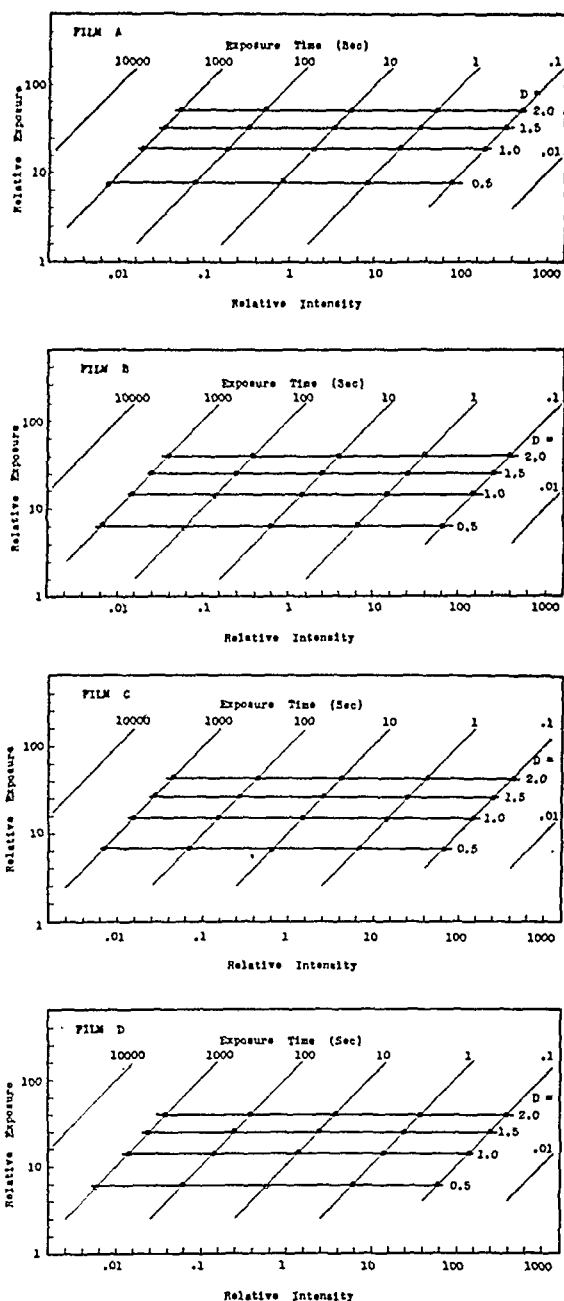


Fig. 3. Curves illustrating absence of reciprocity law failure in four brands of x-ray film when exposed with x-rays directly.

that such films fulfill the reciprocity law completely. The significance of this phenomenon will be discussed later.

#### SIGNIFICANCE OF RECIPROCITY LAW FAILURE

Reciprocity law failure is of considerable importance in several phases of radiography. As previously stated, the speed of a film which exhibits reciprocity law



failure is dependent on the intensity of the radiation with which it is exposed. Thus, a film employed in radiography of the chest, where the intensity of the exposing radiation is relatively high, will have a different speed rating than the same film when used in the examination of the pelvis, where the intensity of the incident radiation is considerably lower. Most radiologists are unaware of this phenomenon, since a film's speed factor does not usually enter directly in the calculation of radiographic exposure technics. Nevertheless, suitable compensation must be made for it, either knowingly or unknowingly, in the preparation of every chart expressing radiographic technical factors, if the chart is to be satisfactory.

Since each film which fails the reciprocity law does so in a manner different from that of any other, it follows that one film may be faster than another at one intensity level, yet slower than the other at another intensity level. This is well shown in Figure 4, where the speeds of the four films whose characteristics are illustrated in Figure 2 are plotted through a considerable range of intensity; the various values were calculated from equation (2). The vertical dotted line indicates the intensity at which an exposure of one second will produce in film C a density of 1.0; a large number of radiographic examinations are done near this intensity level. It will be observed that, when the relative intensity is 10 (approximately that used in chest radiography), film A is considerably faster than film C; yet when the relative intensity is 0.1 (that frequently encountered in the examination of the lateral lumbar spine), film C is the faster. This explains an observation frequently made by radiologists that one brand of film seems preferable to all others for some procedures, while the results obtained with another are more satisfactory under different circumstances. When testing the merits of a new brand of film, it is wise to make roentgenograms of a wide variety of anatomical structures before passing final judgment.

The existence of reciprocity law failure in films exposed with intensifying screens and the lack of such failure in films exposed to x-rays directly are of great importance in industrial radiography. When objects of high atomic number (steel, etc.) are examined, exposures routinely are many minutes in length, and not infrequently exceed several hours. An examination of Figures 2 and 3 reveals that at these low intensities and correspondingly long exposure times, the speeds of films exposed with intensifying screens will not differ significantly from those of films exposed directly to x-radiation. This is one of the reasons why intensifying screens are not widely used in industrial radiography.

Those who use radiographic film for photometric purposes (for the radiographic determination of x-ray intensities) must consider reciprocity law failure when exposures are made with intensifying screens. Failure to do so will obviously introduce sizable errors in the calculated results.

Reciprocity law failure must also be given careful consideration in the design and calibration of radiographic exposure meters (20) and automatic timers (23). It is not possible, however, to discuss this phase of the subject at this time, since restrictions of secrecy imposed by the armed services, for whom these devices are under development, prohibit the disclosure of the methods which have been devised to compensate for the phenomenon.

#### THEORETICAL CONSIDERATIONS

Although the phenomenon of reciprocity law failure has been recognized almost from the beginning of photography, it has been only within the last few years that some of its underlying causes have been understood. This recent clarification of the subject has been largely effected through experimental investigation and the application of the principles of atomic physics to photographic theory. Before pursuing a discussion of the etiology of reciprocity law failure, however, we should pause briefly to review some of the basic prin-

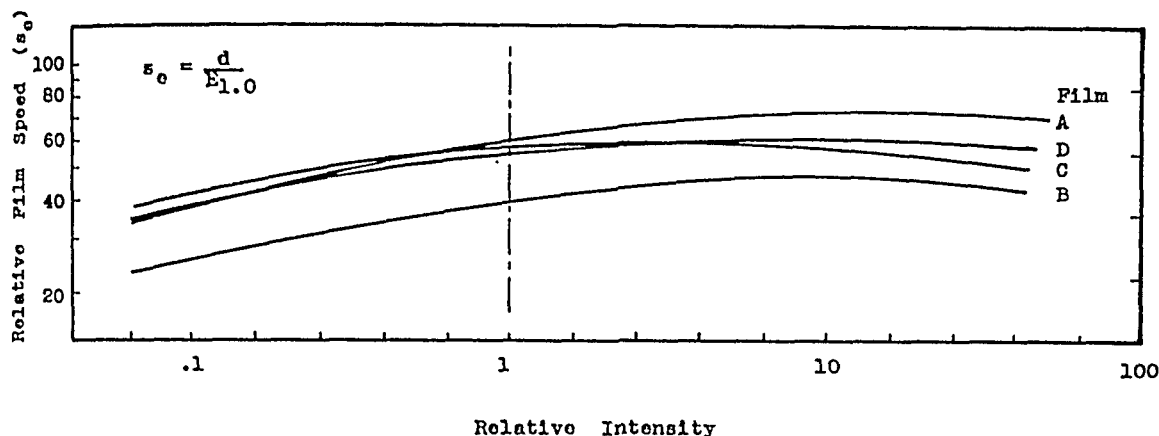


Fig. 4. Speeds of four brands of x-ray film exposed with intensifying screens at various intensity levels.

ciples of the photographic process. Only in this way can a clear understanding of the subject be gained.

Fundamentally, a photographic emulsion consists of a suspension of microscopic crystals of silver halide (principally silver bromide) in gelatin. Also included are minute amounts of silver sulfide concentrated at discrete points over the surfaces of the crystals, and serving as sensitivity-promoting agents. When light or x-rays impinge on the emulsion, some of the crystals are altered in such a manner that they can be reduced to metallic silver by certain reducing agents called developers. The mechanism whereby the crystals are converted into a developable state by the action of radiant energy has been the subject of considerable speculation. Of the many theories which have been suggested, that proposed by Sheppard, Trivelli, and Loveland (24) and recently amplified by Gurney and Mott (25) seems most satisfactory. It is supported by considerable experimental evidence and is in good accord with modern concepts of atomic physics. This theory suggests that when a silver bromide crystal absorbs a quantum of radiant energy, the energy of one of its electrons is raised to a state wherein the electron enters the conduction band of silver bromide and thereby may move freely through the crystal lattice. When thus excited, the electron may follow one of several courses. It may liberate its energy immediately, recombine with its

parent atom, and return the crystal to its original state. Another possibility is for the electron to migrate from the silver bromide crystal to one of the silver sulfide specks. Since the energy level of the conduction band of silver bromide is higher than that of silver sulfide, the electron will give up some of its energy in the process. Accordingly, once the electron is within the conduction band of silver sulfide, it will be trapped there, since it will have insufficient energy to return to the silver bromide crystal.

When an electron is trapped in this manner, the silver sulfide speck becomes negatively charged. This causes a positively charged silver ion to migrate from the bromide crystal to the speck, there to neutralize the charge and be converted to metallic silver. As the exposure of the crystal continues, additional silver will be deposited at the speck and also at the numerous other specks over the surface of the crystal. These submicroscopic foci of silver form nuclei around which the remaining silver of the crystal can be deposited by the action of the developer. Without such nuclei the crystal is not developable.

The theory just outlined appears to be fundamentally sound. As previously pointed out, it is founded on well accepted concepts of atomic physics and is supported by much experimental evidence. Because of limitation of space, none of this evidence has been cited. The publications of Webb

(26) and of Mees (27) furnish excellent reviews of this material.

The Gurney-Mott theory provides for the first time a simple and reasonable explanation of reciprocity law failure. Two factors, one operating at high intensity levels and the other at low intensity levels, are probably responsible for the phenomenon (26). When a photographic emulsion is exposed with radiation of high intensity, large numbers of electrons in the silver bromide crystals will be raised to an excited state within a short interval of time. Some of these electrons will be trapped by the silver sulfide specks and create an electrostatic field which prevents the trapping of additional electrons until the field is neutralized by the migration of silver ions from the crystal. While this migration is taking place, the untrapped electrons will be repelled by the electrostatic field and be driven far afield to be lost to the photographic process. The number of electrons lost in this manner will depend on the rate of electron excitation by the photographic exposure and on the speed of migration of the silver ions. Obviously, the number will become greater as the intensity of the exposing radiation increases. This loss of available electrons causes a diminution in photographic efficiency and, accordingly, the amount of radiant energy required to produce a particular photographic effect becomes progressively greater as the intensity of the exposing radiation increases.

At low intensity levels, loss of film sensitivity may be traced to another cause. There is excellent experimental evidence (25) to show that the submicroscopic foci of silver deposited at the silver sulfide specks are extremely unstable in their early stages of formation and tend to disintegrate readily. If the rate of formation is slow, as is the case when the intensity of the exposing radiation is low, many of the foci may disintegrate before they reach a stable state. Such foci obviously will be lost to the photographic process and a diminution of emulsion sensitivity thereby will result.

These concepts of reciprocity law failure have received considerable support from the experimental studies of Webb (26), and there seems to be good reason to believe that they represent a fairly accurate picture of the mechanism of the phenomenon.

Although the preceding discussion has indicated the probable causes of reciprocity law failure in films exposed with visible light, it has not explained the lack of reciprocity law failure in films exposed with x-radiation directly. As we shall see presently, however, the Gurney-Mott theory may be extended to provide a satisfactory explanation of this phenomenon. When x-radiation falls on a photographic emulsion, high-velocity photoelectrons are liberated. In dissipating their energy, these photoelectrons produce, by interaction with the crystal within which they are located, clouds of low-velocity secondary electrons, the number of which may exceed the number of primary photoelectrons by many thousands of times. The secondary electrons behave similarly to electrons excited by light; that is, some are trapped by silver sulfide specks and contribute to the photographic process. Now the number of secondary electrons produced by each photoelectron is not dependent on the intensity of the x-radiation, but merely on the energy of the quantum absorbed. Furthermore, it is reasonable to assume that when a crystal absorbs one quantum of radiant energy there are sufficient secondary electrons produced to cause the crystal to be converted into a developable state. Thus, the photographic process in emulsions exposed to x-radiation directly is entirely independent of the intensity of the exposing radiation. This being the case, one should expect the reciprocity law to be fulfilled completely by films exposed in this manner.

Further support of these theories may be found in the density *vs.* exposure curves of films exposed with light (or with intensifying screens) and of films exposed directly to x-rays. It is well known that films exposed with light exhibit disproportion-

ately low responses when exposures are small (this characteristic is frequently called photographic inertia), whereas films exposed with x-rays do not. This is just as it should be if the Gurney-Mott theory is valid, for when exposures are small and made with light, many of the silver foci deposited at the silver sulfide specks are likely to be immature. As pointed out above, such foci tend to disintegrate readily and become lost to the photographic process, thereby causing a diminished photographic effect. When exposures are made with x-rays, on the other hand, the absorption of each quantum of radiant energy results in the production of such large numbers of secondary electrons that a stable silver focus is always assured. Therefore, the efficiency of the photographic process under these conditions is not reduced.

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#### BIBLIOGRAPHY

1. BUNSEN, R. W., AND ROSCOE, H. E.: Photochemische Untersuchungen, *Ann. d. Physik* 108: 193, 1859 (2).
2. SCHIENER, J.: Application de la photographie à la détermination des grandeurs stellaires. *Bull. du Comité permanent international pour l'exécution photographique de la carte du ciel* 1: 227, 1889.
3. SCHWARZSCHILD, K.: On the Law of Reciprocity for Bromide of Silver in Gelatine. *Astrophys. J.* 11: 89, 1900.
4. ABNEY, W. DE W.: Failure in a Photographic Law with Very Intense Light. *Phot. J.* 18: 302, 1894.
5. ENGLISCH, E.: Das Schwärzungsgesetz für Bromsilbergelatine. Halle, W. Knapp, 1901.
6. SHEPPARD, S. E., AND MEES, C. E. K.: Investigations on the Theory of the Photographic Process. London, Longmans, Green & Co., 1907.
7. KRON, E.: Über das Schwärzungsgesetz photographischer Trockenplatten. *Ann. d. Physik* 41: 751, 1913 (4).
8. WEBB, J. H.: Photographic Reciprocity Law Failure for Radiations of Different Wave Length. *J. Optic Soc. America* 23: 317, 1933.
9. JONES, L. A., AND WEBB, J. H.: Reciprocity Law Failure in Photographic Exposures. *J. Soc. Motion Picture Eng.* 23: 142, 1934.
10. HALM, J.: On the Method of Determining Photographic Star Magnitudes Without the Use of Screens or Gratings. *Monthly Not. Royal Astronom. Soc.* 82: 473, 1922.
11. ARENS, H., AND EGGERT, J.: Über die Schwärzungsfläche photographischer Schichten. *Ztschr. f. phys. Chem.* 131: 297, 1928.
12. PRECHT, J.: Notation in *Phys. Ztschr.* 1: 48, 1899.
13. KRONCKE, H.: Über die Messung der Intensität und Härte der Röntgenstrahlen. *Ann. d. Physik* 43: 687, 1914 (4).
14. FRIEDERICH, W., AND KOCH, P. P.: Method zur photographischen Spektralphotometrie der Röntgenstrahlen. *Ann. d. Physik* 45: 399, 1914 (4).
15. GLOCKER, R., AND TRAUB, W.: Das Gesetz der photographischen Schwärzung durch Röntgenstrahlen. *Phys. Ztschr.* 22: 345, 1921.
16. DERSHEM, E.: Direct Comparison of Photographic and Ionization Methods of Measuring X-ray Intensities. *Phys. Rev.* 42: 908, 1932 (4).
17. BELL, G. E.: Photographic Action of X-rays. *Brit. J. Radiol.* 9: 578, 1936.
18. HOLTHUSEN, H., AND HAMANN, A.: Radiumdosimetrie auf photometrischen Wege. *Strahlentherapie* 43: 667, 1932.
19. ROSENBERGER, H., AND GOLDBABER, G.: Erfahrungen mit der photographischen Methode in der Radiumdosimetrie. *Strahlentherapie* 51: 45, 1934.
20. MORGAN, R. H.: Studies in Roentgenographic Exposure Meter Design. *Am. J. Roentgenol.* 48: 88, 1942.
21. WHITE, D. R.: Sensitometric Testing of X-ray Film. *X-ray Technician* 5: 109, 1934.
22. WEBB, J. H.: Effect of Temperature Upon Reciprocity Law Failure in Photographic Exposures. *J. Optic. Soc. America* 25: 4, 1935.
23. MORGAN, R. H.: Photoelectric Timing Mechanism for the Automatic Control of Roentgenographic Exposure. *Am. J. Roentgenol.* 48: 220, 1942.
24. SHEPPARD, S. E., TRIVELLI, A. P. H., AND LOVELAND, R. P.: Studies in Photographic Sensitivity. VI. Formation of the Latent Image. *J. Franklin Inst.* 200: 51, 1925.
25. GURNEY, R. W., AND MOTT, N. F.: Theory of the Photolysis of Silver Bromide and the Photographic Latent Image. *Proc. Roy. Soc. (Ser. A)* 164: 15, 1938.
26. WEBB, J. H.: Theory of the Photographic Latent-Image Formation. *J. App. Phys.* 11: 18, 1940.
27. MEES, C. E. K.: Theory of the Photographic Process. New York, Macmillan Co., 1942.

# Supervoltage Roentgen Therapy of Esophageal Carcinoma<sup>1</sup>

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THIS DISCUSSION will be limited to a consideration of radiation therapy of epidermoid carcinomas of the thoracic portion of the esophagus. Carcinomas of the upper third, as well as adenocarcinomas of the lower third, are excluded, as they present a different therapeutic problem, and everywhere in cancer therapy progress has been hastened by the recognition of the different types of tumors which may occur in a particular organ.

Carcinomas of the upper third or cervical portion of the esophagus are biologically, therapeutically, and prognostically to be considered in the same group as hypopharyngeal carcinomas. While technical advancements may still improve their curability, we feel that the principles of treatment here are established. For these carcinomas 200-kv. radiation offers today an approximate mean curability of 20 per cent. While this figure may eventually be improved by better technic and the application of higher voltage, we do not believe that the latter *per se* offers a fundamentally new approach.

The main reasons for the better results in tumors of the cervical, as compared with those in the thoracic esophagus, are probably their earlier recognition and their location, which permits the application of a sterilizing dose into the tumor with radiation of medium voltage.

The exclusion of the glandular carcinomas of the lower third of the esophagus does not mean that these tumors are not responsive to irradiation. Some of the polypoid adenocarcinomas of the cardia are quite radiosensitive, and a number of cases treated by others (Merritt) and by ourselves have shown definite improvement under radiation therapy, as evidenced

by the patient's general condition, temporary disappearance of the tumor as shown roentgenographically, and a change in the gastroscopic picture. These tumors are, however, biologically different from the epidermoid carcinomas and in the interests of clarity it seemed wiser to eliminate them.

Treatment of carcinoma of the thoracic portion of the esophagus is still an unsolved problem. Although the number of apparent surgical cures has increased with the improvement of thoracic surgery during the last decade, the procedure is so formidable, and the prognosis in the individual case so unpredictable, that operation cannot be considered a solution. The local application of radium—intracavitary or interstitial—has universally failed; with the exception of Guisez, no one has reported any cures. This procedure has been discarded by more experienced observers because of the unsatisfactory results and the danger of acute perforation (Zupping-ger).

Two hundred-kilovolt roentgen therapy of these esophageal cancers is the only radiologic approach which, so far, has given sufficiently uniform palliative results to warrant its consideration as a clinical procedure with definite indications and contraindications. Reports of larger series treated consistently by this method, as well as our own experience, demonstrate that in about one-half of the patients the tumor shows sufficient response to overcome the obstruction and thus outweigh the disadvantages of the rather formidable course of therapy. In these cases it is possible to avoid a gastrostomy and the patients usually remain in good condition six to eighteen months after treatment. Most of them die not of starvation but from perforation into the trachea or bronchi, with rapidly progressing aspiration

<sup>1</sup> From the Tumor Institute of the Swedish Hospital, Seattle, Wash. Read by title at the Twenty-ninth Annual Meeting of the Radiological Society of North America, Chicago, Ill., Dec. 1-2, 1943.

pneumonia. Zuppinger, in 161 cases, obtained a regression of the tumor with improvement of the stenosis in 79, or almost 50 per cent. Twenty-one cases remained stationary and 61 showed no improvement, but in most of this latter group treatment had to be discontinued for one reason or another. Strandqvist obtained primary freedom from symptoms in three-fourths of 36 cases treated with 180-kv. radiation.

We believe that 200-kv. radiation therapy, which now has its well outlined indications and limitations, is justified and preferable to gastrostomy and mechanical dilatation, provided the patient's general condition is still good enough to support the procedure and provided no metastatic foci can be demonstrated. It is, however, equally obvious that this procedure has produced what can be called permanent cures in such exceptionally rare instances that we should consider these accomplishments as curiosities rather than as promising future progress with this technic. How careful we must be with the interpretation even of apparently cured patients is shown by Baum's case. His patient, treated with 15,000 r (200 kv.) through three portals, was reported radiologically symptom-free for six years in 1936. In a recent personal communication, Doctor Baum informed us that this patient remained free of clinical and radiological evidence of disease for nine years but during the tenth year had a local recurrence and subsequently died of pulmonary and liver metastases. In the light of this experience, it seems futile to put too much emphasis on a number of cases reported in the literature as cured for two to five years. Some of the late results, furthermore, are those encountered in the upper third of the esophagus, which is outside this discussion (Pohle, Nielsen, Zuppinger).

Nielsen attempted to discover the reasons for the different results in tumors located in the cervical and those located in the intrathoracic portion of the esophagus. He found the efficient tumor dose to be about 4,000 to 4,500 r given in a period of

from six to seven weeks. He gave to his cervical tumors between 6,000 and 12,000 r, the tumor dose varying between 3,000 and 6,000 r. For the tumors of the intrathoracic portion this problem cannot be solved with 200-kv. radiation. It is necessary to use five or six fields. A daily dose of more than 350 r is usually not tolerated; a daily dose below 300 is usually not efficient. It is difficult to apply more than 12,000 r without severe complications if the fields are reasonably large. Strandqvist comes to about the same conclusion with regard to the dose applied to the tumor. In those patients who remained well for two years, the tumor dose was 4,350 to 5,000 r given over a period of thirty-five to forty days. He believes that, were it possible to apply a total tumor dose of 5,000 to 6,000 r in thirty to forty days, the results would improve.

These experiences with 200-kv. x-ray therapy show conclusively that the tumors are essentially responsive to radiation therapy and that the obstacle to complete sterilization may well be found in the inadequate tumor dose. The degree of radiosensitivity of these neoplasms, as evidenced by their response to 200 kv. radiation, is in agreement with the pathological type of tumor—gross and microscopic—found in the esophagus. The detailed histological classification of 139 cancers of the esophagus by Zuppinger shows the following distribution: 85 cases, or 61 per cent, squamous-cell carcinoma; 22 cases, or 16 per cent, carcinoma simplex solidum; 22 cases, or 16 per cent, semi-epidermoid carcinoma; 7 cases, or 3.6 per cent, adenocarcinoma. Of 52 squamous-cell carcinomas, of which the slides were still available at the time of his review, Zuppinger found 41 of the mucous membrane type and 11 of the skin type of differentiation. This indicates that the undifferentiated cancers, or those of a low degree of differentiation, represent at least 30 per cent of the epidermoid carcinomas of the esophagus. From a biological point of view then, these tumors are similar to those of the mucous membrane of the oral

cavity and of the cervix uteri. They do not represent very highly radiosensitive tumors, but they are of a degree of radiosensitivity compatible with their curability by radiation without intolerable damage to the surrounding structures.

From the gross pathologic appearance, it is possible to differentiate exophytic or polypoid tumors from the more infiltrating types. In Zuppinger's series 50 per cent were exophytic carcinomas, 44 per cent infiltrating, and 5 per cent he could not classify. In most cases it is possible to come to some conclusion as to the gross type of tumor from the radiologic appearance and clinical symptoms. Esophagoscopy will add assurance to the clinical classification. As one would expect, Zuppinger found that the polypoid tumors responded to radiation therapy to a greater extent than the infiltrating forms and, since they also metastasize later, they should represent those most amenable to roentgen therapy.

On the basis of clinical as well as general pathologic considerations, it seems logical to assume that a high percentage of carcinomas of the thoracic esophagus are essentially amenable to external radiation therapy and that an improvement in technical details may insure curability of a certain number, as in the case of other epidermoid carcinomas located in a physically more favorable position. Logically the increase in penetration should constitute a definite step forward toward this goal.

It was therefore with great eagerness that in 1939 we accepted the opportunity to treat carcinomas of the esophagus with 800-kv. apparatus. We have, however, in the ensuing four and one-half years seen only 10 carcinomas of the esophagus, although elsewhere we had had 2 or 3 cases under treatment at any given time. It seems that the number of carcinomas of the esophagus in this part of the country is actually small, for thoracic surgeons, as well as some of the more active x-ray diagnosticians, inform us that they rarely see a case. It may be, also, that the condi-

tion is generally considered so hopeless that any form of treatment seems futile and the patient is not referred to a thoracic surgeon or x-ray diagnostician—to say nothing of a radiotherapist. As a matter of fact, even some radiologists consider gastrostomy as the palliative procedure of choice, probably because the dose of radiation usually applied has been too low to produce any result. Case 2, recorded below, is an instructive example of this attitude. We have seen cases treated with 140-kv. radiation, a procedure which will quite naturally discourage the sending of such patients for radiation therapy. This type of treatment will discredit the whole field of radiation therapy in esophageal cancer in the eyes of patients, practitioners, and surgeons alike.

Naturally radiotherapy should be considered only if the patient's general condition is fair, if the weight loss is not too great, and if there is no demonstrable evidence of spread of the disease beyond the esophagus. A report by Watson and Urban seems to substantiate this conclusion. In a group of 21 patients with intrathoracic carcinomas of the esophagus treated with million-volt roentgen rays, 17 (81 per cent!) showed an extreme loss of weight, 4 had enlarged lymph nodes, 5 had liver nodularities, and 12 required a preliminary gastrostomy. We would feel that the majority of these cases were unsuitable for irradiation. It is not surprising, therefore, that at the time of the report only 1 out of this group of 21 patients had remained without sign of recurrence for thirty months after treatment.

Of our 10 patients, 4 were refused treatment because they had either demonstrable metastases or the general condition was not sufficiently good to support so formidable a procedure. In 1 case treatment was discontinued after only a small amount of radiation had been given, because of rapid deterioration. We have therefore treated only 5 patients with doses considered adequate. One of these is without radiological evidence of local recurrence after three and a half years (Case



Figs. 1 and 2. Case 1: Biopsy specimen showing squamous-cell carcinoma, grade 2, and initial roentgenogram (April 27, 1940).

1). One shows a recurrent stenosis, probably with liver metastasis, after two years (Case 2). One patient, who showed radiologically a penetrating ulcer in an infiltrating stenosing carcinoma at the beginning of treatment, had a temporary improvement of the stenosis for about four months and then died after eleven months with local recurrence and liver metastases (Case 3). One patient died after three months, apparently of perforation with lung abscess. One patient, with an extensive anaplastic polypoid carcinoma, died after four months with extensive liver metastases. It should go without saying that the number of cases is much too small and the time too short to permit definite conclusions. The only excuse for this premature report is the hope that we might have a chance to discuss these problems openly in order to improve the technical approach and stimulate reports by others who have a larger material available. We feel that, in a field in which final conclusions cannot be reached until at least five to ten years of observation have elapsed, we are justified in pausing at times to evaluate our observations to date in order to recognize what a new procedure has or has not accomplished, and to consider where improvements are possible on the basis of our existing knowledge. Such a discussion is warranted in order to give patients the benefit of past experience, no matter how meager. The

following case reports are presented only with these reservations.

Treatment was administered with 800 kv., 100 cm. T.S.D., and an essential filtration of 4.5 mm. lead, giving an exposure rate of approximately 25 r per minute for the fields used. All doses were measured on the skin.

CASE 1: B. B., 47-year-old male, was admitted April 15, 1940. In September 1939 he had what he thought was a chest cold, which persisted for about one month and was associated with hiccup following meals. He was examined radiologically but nothing was found. About two weeks following the radiologic examination, he was re-examined and at that time an irregularity was discovered in the esophagus. Esophagoscopy was then done and a biopsy specimen was reported as not malignant.

In the early part of January 1940, because of persistent pain after eating and loss of weight, the patient went to the Mayo Clinic, where a diagnosis of cancer of the esophagus was made. The report describes a lesion involving the distal portion of the esophagus and the lesser curvature of the stomach at the cardia (Dr. H. H. Schmidt). Esophagoscopy showed an ulcerated bleeding lesion at the cardia. A biopsy specimen was taken through the esophagoscope and a squamous-cell epithelioma, grade 2, was found (Fig. 1). Dilatation (up to 45 French) was done and the patient was advised against further therapy.

Fluoroscopic examination by Dr. T. W. Blake, following admission to the Swedish Hospital (April 1940), showed a carcinoma, apparently involving 2 inches of the esophagus above its entrance into the stomach. There was also involvement of approximately 2 inches of the upper part of the stomach, especially on the lesser curvature side (Fig. 2).



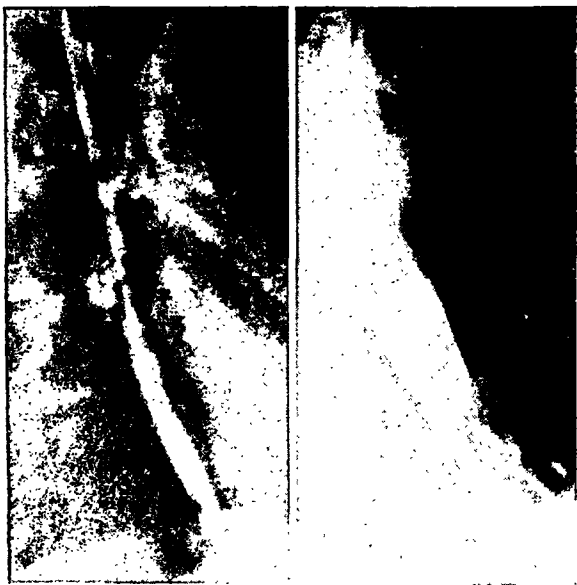


Fig. 3. Case 1: Roentgenograms made Oct. 13, 1941.



Fig. 4. Case 1: Roentgenograms made Nov. 24, 1942 (Courtesy of Dr. F. Templeton).

The patient received x-ray therapy between April 15 and May 30, 1940, as follows: anterior epigastric field, 3,500 r; posterior epigastric field, 4,450 r; second anterior epigastric field, 1,900 r. Total 9,850 r in 46 days.

There was a partial overlapping of the two anterior fields. The first field included the stenotic area of the esophagus only, while the second field attempted to include the cardiac extension of the lesion. Field sizes varied between  $10 \times 14$  and  $9 \times 10$  cm., being mainly  $10 \times 10$  cm.

While the patient had declined in weight from 175 pounds prior to the onset of symptoms to 126 pounds at the beginning of irradiation, he had reached 137 pounds at the end of treatment. Swallowing improved after about 2,300 r and throughout the treatment he ate well, usually six meals a day, without regurgitation or discomfort. He steadily regained strength while under treatment. At the completion of therapy there was a moist radio-epidermitis over both anterior and posterior fields, which healed within three or four days. Fluoroscopic examination on May 11, 1940, after 6,000 r were delivered, showed the passage completely open for liquids and without stenosis. There was still a filling defect in the lower esophagus surrounded by an apple-sized shadow apparently representing the tumor.

On July 8, 1940, the patient informed us by letter that his weight was 145 pounds and that he was eating everything. He was re-examined on Oct. 13, 1941, one and a half years after treatment. His general condition was excellent, his weight 160 pounds. He stated that he ate everything without difficulty and had no pain or cough. He had been

working full time during the past year. Fluoroscopic examination showed some, but not marked, residual narrowing of the distal two inches of the esophagus and some indication of rigidity of the medial wall of the stomach for a distance of approximately one inch adjacent to the site of insertion of the esophagus into the stomach (Fig. 3).

On Nov. 24, 1942, the patient was examined by Dr. F. Templeton of the University of Chicago (Fig. 4). His report follows: "The esophagus, stomach and duodenum are normal except for some distor-

tion of form in the lower end of the esophagus. Peristaltic waves passed through the esophagus to the stomach. There was not the slightest suggestion of neoplasm. Peristaltic waves began high on the stomach, then progressed through the antrum. The duodenal bulb was normal. The fundus of the stomach filled out well.

"Serials 1 to 4 inclusive, multiple views of the lower end of the esophagus and stomach. First view, serial 4, made during the passage of first swallow of barium into the stomach. This view and the third view of serial 4 show the lower end of the esophagus well filled. The distortion of the mucosa suggestive of radiating folds about 2 cm. above the level of the diaphragm is shown on first view, serial 3, third view, serial 2.

"*Impression:* Except for some scarring in the lower 2 or 3 cm. of the esophagus, I see no evidence of lesion. Patient is in excellent general condition, is keeping his weight around 160 pounds, and is working full time without any subjective complaints."

CASE 2: J. R., 62-year-old male, was admitted July 30, 1941. For two and a half years he had complained of indigestion and lack of appetite, and for the past year he had had difficulty in swallowing. Since September 1940, he had been able to swallow only liquids. *At that time he was examined by a radiologist, who recommended gastrostomy only.* Since then the esophagus had been *regularly dilated*. At the examination in September, a stenosis of the middle third of the esophagus with prestenotic dilatation was found. The patient's weight at that time was 163 pounds. On admission he weighed 122 pounds. Only a small amount of liquid could be passed. When he was admitted, he had received roentgen therapy elsewhere, between June 25 and July 9, 1941, a total of 1,260 r with 0.25 mm. copper (!), voltage not stated.

X-ray examination by Dr. T. W. Blake, on July 30, 1941, showed a carcinoma at the level of the 7th dorsal vertebra, with some obstruction (Fig. 5).

Esophagoscopy by Dr. James Blackman, on Aug. 12, showed the mucosa greatly thickened and rough in appearance at the junction of the upper and middle thirds of the esophagus. The lumen was reduced to approximately 0.5 cm. in diameter by a polypoid tumor. A specimen taken from this mass showed squamous-cell carcinoma.

Between Aug. 13 and Sept. 23, 1941, the patient received the following roentgen therapy with 800 kv.: anterior mediastinum 5,150 r; posterior mediastinum 4,950 r (Fig. 10). Total 10,100 r in 41 days. Field sizes 8 X 10 to 10 X 10 cm.

After fifteen treatment days, or about 3,000 r, the patient experienced more difficulty in swallowing and excessive salivation, indicating an increase of the obstruction. The dose was then somewhat reduced and after about 4,000 r, on the 20th treatment day, there was an improvement in swallowing and general condition. Beginning Sept. 18, 1941, there was



Fig. 5. Case 2: Roentgenogram made July 30, 1941, showing carcinoma at the level of the 7th dorsal vertebra.

again a deterioration, and the patient was unable to swallow. Treatment was therefore discontinued until the obstruction had improved and feeding once more became possible on Sept. 29.

Fluoroscopic examination on Oct. 6, 1941, showed no obstruction and an almost normal esophagus. There was a small area of narrowing at the site of the former obstruction, which could be demonstrated only with paste-like barium. There was no prestenotic dilatation.

On the 33d treatment day there was a beginning moist reaction over the anterior field, which healed in ten days. There was a severe erythema over the posterior field only.

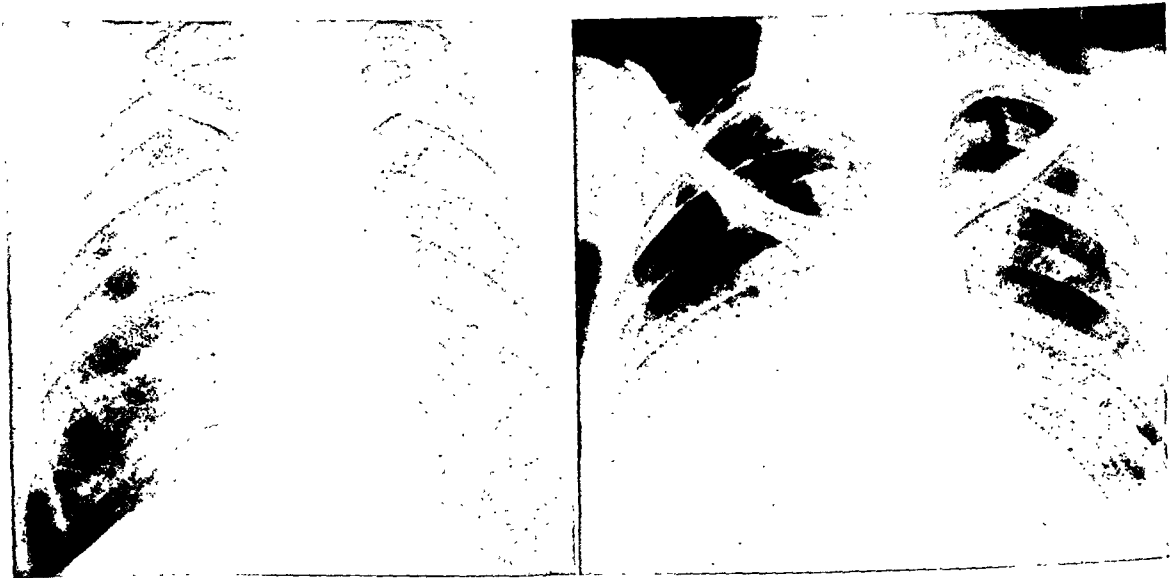
Following the improvement as evidenced by clinical observation and x-ray examination on Oct. 6, 1941, *additional roentgen therapy* was given to one anterior oblique (60 degree) field of 10 X 12 cm., 4,750 r being delivered to this field in 17 days.

On Oct. 13, 1941, on the 63d treatment day, after 12,350 r had been given, the patient complained for the first time of pain over the treated area on swallowing, probably indicating a reaction of the esophageal mucosa. During the following days there were occasional acute and apparently spastic occlusions of the esophagus, lasting only a few minutes each time, probably due to the irritability of the esophageal mucosa during the radiation reaction.

On Oct. 27, 1941, a second esophagoscopy was done by Dr. James Blackman. Stenosis was again encountered at the junction of the superior and middle thirds of the esophagus. A small tag of tissue



Fig. 6. Case 2: Roentgenograms made Feb. 17, 1942.



Figs. 7 and 8. Case 2: Chest roentgenograms showing (left) radiation fibrosis (Feb. 17, 1942) and (right) mediastinitis (Sept. 20, 1943).

protruding into the lumen at about the 7 o'clock position was found. This tag was smooth and covered with apparently normal mucosa. The instrument could be passed approximately 1 cm. beyond the first abnormality and the lumen was then found reduced to approximately 1 cm. in diameter. This reduction was caused by a rather large polypoid growth in the left lateral wall. The esophageal lumen was at least twice the size it was at the first esophagoscopy examination and the tumor was now smooth in outline and apparently covered by normal esophageal mucosa.

Between Oct. 28 and Oct. 31, 1941, additional roentgen therapy, 1,350 r through one left posterior oblique field of  $10 \times 10$  cm., was given. This brought the *total amount of radiation to 16,200 r in 81 days*. There was an 8-pound gain in weight during the treatment period.

Re-examination on Dec. 12, 1941, showed the patient to be in good condition, with the same weight as on discharge. He could swallow all liquids without difficulty but stated there was some delay in the mid-thoracic region on swallowing of solids. X-ray examination at this time showed a diminution in the amount of obstruction. There was still a slight narrowing of the esophagus at the level of the 7th dorsal vertebra, but this was apparently associated with spasm, since there was considerable distensibility of the esophagus at the site of the previous lesion.

The patient was re-examined on Feb. 17, 1942, three and a half months after completion of roentgen therapy. At this time he could swallow everything. Only occasionally, very solid food produced a sensation of retardation for a short while before it passed on. On fluoroscopy the esophageal passage was completely free for fairly thick barium and there was normal expansion in the region of previous stenosis. There remained a slight irregularity in this area toward which the mucosal folds converged (Fig. 6). The x-ray examination of the chest showed a diffuse opacity in the hilar region, extending symmetrically as smooth bands to the left and to the right (Fig. 7). From this examination it was impossible to determine whether this was a beginning mediastinal and pulmonary fibrosis or an extension of the disease from mediastinal metastatic foci. The symmetrical character of this lesion was interpreted as in favor of fibrosis.

The patient was last seen on Sept. 20, 1943, when he stated that he was swallowing well until November 1942. Since that time he had again experienced difficulty with solid foods and could swallow only semisolids and, during the last two months, only liquids. He was in a very reduced general condition. Fluoroscopically a stenosis at the level of the 7th dorsal vertebra was again demonstrable (Fig. 9). Only very thin barium passed at this level. X-ray study of the chest showed a massive extension into the right lung with partial atelectasis, indicative, in all likelihood, of progression of mediastinal me-



Fig. 9. Case 2: Sept. 20, 1943.

tastases into the right lung. There was a moderate amount of fluid in both pleural cavities. However, the possibility of a severe radiation fibrosis and mediastinitis must be considered, if one compares the chest findings on Figures 7 and 8. The liver was greatly enlarged and nodularities were palpable on the anterior surface. There was an edema of both legs. The main complaint was dyspnea.

This case is considered a failure, although from our findings it is not possible to determine whether the patient's condition is due to recurrent disease or to a severe mediastinal fibrosis with mediastinitis. The comparison of the films of Feb. 17, 1942, and Sept. 20, 1943, suggest this possibility to us in view of the excessive amount of radiation received. We believe that the patient was overtreated, and so excessive a dose will be avoided in the future, since we know from experience with other cancers that a cure cannot be forced by an increase in the dose only.

CASE 3: A. R., 65-year-old white male; was admitted Jan. 16, 1940. In November 1939, he first noticed a stoppage when he ate solid food. For one month he could take only liquids. There was occasionally a regurgitation of whitish material, but no bleeding or pain. Later there had been some cough. Apparently there was no considerable loss of weight. The average weight was 178 pounds; weight on admission 155 pounds.

On examination the patient was found in good general condition. Clinically nothing abnormal was found with the exception of an enlarged liver, palpable about 4 cm. below the costal arch in the mid-

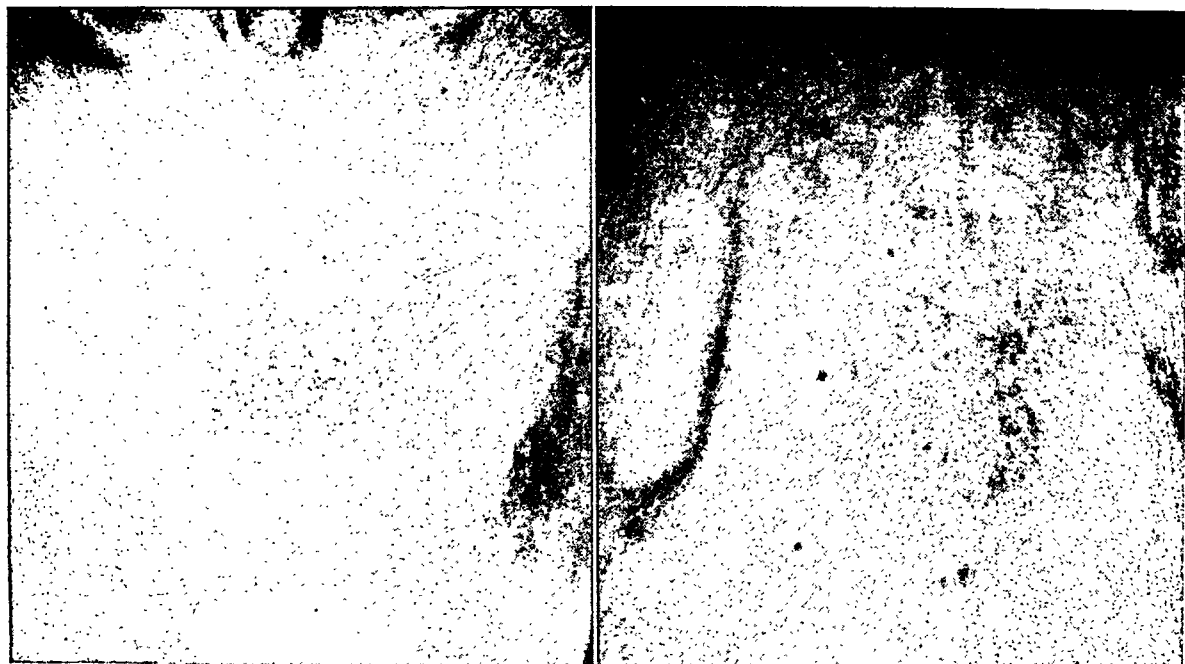


Fig. 10. Case 2: Skin reaction after 5,150 r in 41 days to anterior field (left) and 4,950 r in 41 days to posterior field (right).

line. There was an ill-defined lump palpable under the right rectus muscle in the region of the liver, apparently moving with the liver on inspiration. The pulse was 120, with an irregularity which clinically gave the impression of a fibrillation. On electrocardiographic examination, this was diagnosed as an auricular flutter 3 to 1, ventricular extrasystoles.

Fluoroscopic examination by Dr. T. W. Blake showed a carcinoma at the junction of the lower and middle third of the esophagus at the level extending from the upper circumference to the lower circumference of the 10th dorsal vertebra. The length of the lesion was 2.5 cm. There was a small ulceration demonstrable in the lateral circumference to the right of the stenotic canal, indicative probably of imminent perforation (Fig. 11A).

The patient received roentgen therapy, between Jan. 18 and March 15, 1940, with 800 kv., as follows: anterior field, 4,578 r; posterior field 4,150 r; right anterior oblique 3,000 r; left posterior oblique 1,000 r. Total, 12,728 r in 53 days.

While during the first two and a half treatment weeks the patient was swallowing liquids well, there was increased regurgitation of fluids beginning on the 19th day with increasing difficulty in swallowing and some subjective complaint of associated soreness. This was interpreted as due to an edema around the lesion, since the dose at that time was only around 3,000 r. This difficulty cleared up rapidly, and after 6,000 r were delivered the patient could, beginning on the 36th day, swallow semisolid foods easily. From then on there was a steady improvement of the clinical symptoms of stenosis. At the end of treatment there was a moist epidermitis

over the anterior field, with a deep erythema and scaling over the posterior fields. This healed rapidly.

Fluoroscopy on the 40th treatment day showed the barium passing freely and no stenosis (Fig. 11B). X-ray examination on March 25, 1940, showed the barium passing easily throughout the esophagus. There was still an irregularity in the anterior and posterior circumference extending for 3.5 cm. Altogether, the comparison of this examination with the examination prior to treatment showed a marked improvement.

On May 11, 1940, the patient was in excellent condition, eating everything without difficulty. There was no trace of radiation reaction over the anterior field at this time. There was some residual desquamation with bronzing over the posterior field. The weight was 170 pounds, a gain of 15 pounds.

In June 1940, the patient again noticed difficulty in swallowing and when he returned on July 1, 1940, for re-examination, he was unable to take solid foods. There was no pain in the chest nor cough. Fluoroscopy showed a stenosis at the site of the former lesion. There was practically the same amount of obstruction as was seen at the time of examination on Jan. 16, 1940.

On Dec. 4, 1940, the patient reported by letter that he could still swallow liquids and semiliquids but that he had again lost weight and weighed only 128 pounds.

Death occurred on Feb. 5, 1941. The postmortem examination, by Dr. Straumfjord in Astoria, showed a carcinoma of the esophagus measuring 5.5 cm. in

length. There was a lymph node measuring 2 cm. in diameter behind the esophagus at its cardiac end. Metastases were found in the liver. Sections from liver and esophagus showed carcinoma.

#### DISCUSSION AND CONCLUSIONS

The cases recorded above are obviously meaningless from the point of view of proving or disproving the possibility of cure of esophageal carcinoma by supervoltage roentgen therapy. The fact that one patient was clinically and radiologically well for three and a half years does not demonstrate the superiority of 800-kv. over 200-kv. radiation, since occasional instances of

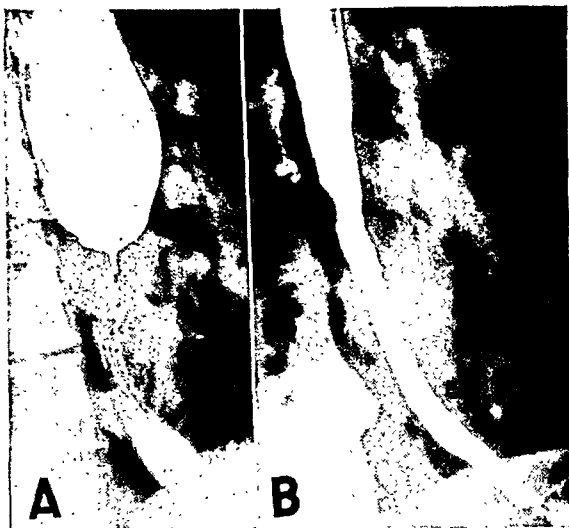


Fig. 11. Case 3.

freedom from symptoms for even longer periods following irradiation at 200-kv. have been reported as therapeutic curiosities. However, careful clinical observations and their evaluation in comparison with the more extensive experience with 200-kv. radiation, as well as theoretical considerations, have convinced us that it is worth while to continue work in this direction, and we believe that this procedure may enable us in the future to cure a certain number of carcinomas of the thoracic esophagus with more regularity.

The response of esophageal carcinomas to 200-kv. radiation has shown conclusively that they are essentially amenable to radiation therapy, since they exhibit a uniform and predictable response, indi-

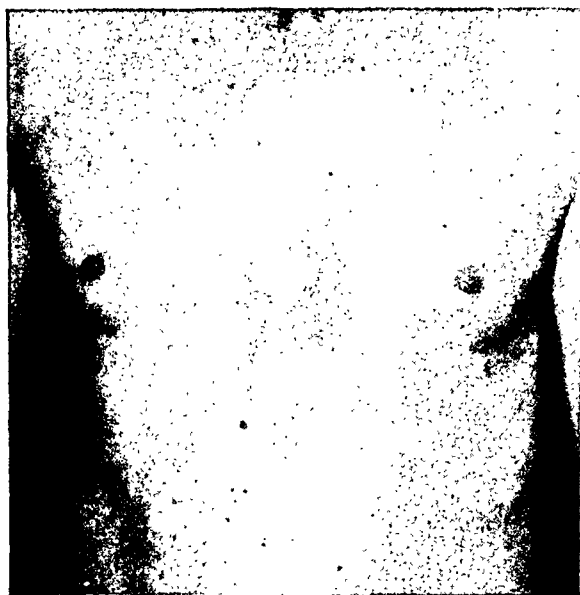


Fig. 12. Case 3: Anterior field after 4,580 r in 43 days (July 1, 1940).

cating a degree of radiosensitivity which is to be anticipated from their microscopic structure. That cures are only rarely accomplished, and results are merely palliative, is due to well understood physical as well as clinical considerations.

An approximate physical calculation and measurements demonstrate that it is physically impossible to introduce adequate cancer-sterilizing doses into tumors at this location with 200-kv. radiation. From experience with tumors of similar histology in other locations, we may assume that approximately 5,000 r, delivered to the tumor within four to five weeks, may be an average sterilizing dose. The distance of a carcinoma of the esophagus, at the level of the hilus, in a patient of average build, is approximately 11.5 cm. from the anterior and 10.5 cm. from the posterior chest wall (Zuppinger). As can be seen from Table I, which records measurements in a presdwood phantom at these levels, the depth dose with 200 kv. is approximately 35.2 and 38.8 per cent of the skin dose, respectively, with a field  $10 \times 14$  cm. With decreasing field size the conditions become even less favorable at this voltage. The skin will not well tolerate more than 4,000 r as a maximum with adequate fields and 200 kv. With this skin

TABLE I: TUMOR DOSE AT 10.5 CM. AND 11.5 CM. DEPTH, MEASURED IN PRESWOOD PHANTOM (Field Size, 10 X 14 cm.)

	200 Kv. 2 mm. Cu. 70 cm. T.S.D.	800 Kv. 4.5 mm. Pb, 100 cm. T.S.D.
Skin dose	100	100
Depth dose 10.5 cm.	38.8%	50.8%
Depth dose 11.5 cm.	35.2%	44%

exposure the dose delivered to the tumor through the anterior portal is about 1,408 r; through the posterior portal, 1,552 r. Thus a total of 2,960 r will be delivered into the tumor through the anterior and posterior fields combined. Actually, it will usually not be possible to give more than 3,500 r over one skin field, which further reduces the tumor dose. In view of these facts, treatment with 200-kv. radiation is always given through more than two portals, and in very careful calculations Zuppinger has demonstrated that, at each level of the esophagus, a different selection of fields would improve the tumor dose. His calculations have taken into account that for some oblique and lateral fields the air-containing tissues are mainly traversed and that the difference in distance is thus partly balanced. As we shall see presently, however, the use of large fields has the disadvantage of a very considerable volume dose and the additional difficulty of inaccurate aiming for the oblique portal, with the consequent necessity of increasing the field size in order to be certain that the tumor is included.

Measurements with 800-kv. radiation of the type we have used have shown that the depth dose at 10.5 cm. is 50.8 per cent and at 11.5 cm. 44 per cent. With this type of radiation the skin can easily tolerate 5,000 r in a period of four to five weeks, with only a mild moist reaction which heals within a few days. Consequently, it is possible to introduce into the tumor through the anterior field an approximate tumor dose of 2,200 r and through the posterior field 2,540 r, or a total of 4,740 r, utilizing only one anterior and one posterior field. This means that with super-

voltage it may be possible to apply an adequate tumor dose by using anterior and posterior fields only. Oblique fields may be added to increase the tumor dose when this is required, but it may not be necessary to add as much through these portals as is done with 200-kv. radiation in order to obtain equal distribution over four or six fields.

The clinical observation of our patients under treatment has shown that supervoltage radiation is tolerated much better than 200-kv. radiation for this type of lesion. This is due in part to the quality of the radiation itself; partly, however, to the possibility of reducing the field sizes, since we can apply the greater portion of the treatment through one anterior and one posterior field. For these the aiming is considerably more accurate than for the oblique fields, which must therefore be larger. It must also be considered that the skin reaction over as large an area as is covered by four or six chest fields has in itself a considerable influence on the patient's general condition.

In order to improve the accuracy of positioning for the oblique fields, a wooden arch, which we have constructed, is placed over the patient's chest during fluoroscopy and the angulation of the body in relation to the table is outlined on the skin (Fig. 13). It is thus possible, by comparing the skin marks with the position of the wooden arch, to reproduce exactly the same position every day.

In respect to the indications for roentgen therapy in carcinoma of the esophagus and the question of a preliminary gastrostomy, we feel that these have now changed. We believe that with 200-kv. radiation no cures can be accomplished; that all we can attempt is improvement of the obstruction in order to avoid gastrostomy. We therefore feel quite strongly that, so far as 200-kv. radiation is concerned, a preliminary gastrostomy defeats the purpose of the procedure and we accordingly refuse patients with gastrostomy for palliative treatment only.

For 800-kv. radiation the situation is otherwise. Here we still hope to attain a

cure but we realize that the procedure is of such a magnitude that only a patient in good general condition can support it. It is evident that the patient should be treated as thoroughly as possible, and this means that fluids at least should be able to pass freely in order that he may obtain adequate nourishment during therapy. Patients who have lost too much weight are not in a condition to support this treatment. If there is some hope of cure and we believe that the poor general condition is due to starvation rather than to cachexia from tumor, we feel that a preliminary gastrostomy is indicated in order to make it possible for the patient to support the treatment. It should be kept in mind, however, that gastrostomy is not as harmless a procedure as it is usually considered. We therefore feel that it should be avoided whenever possible, not only because of the primary risk of the operation itself, but also because of its psychological effect. The gastrostomy and accompanying skin irritation also limit the skin tolerance in the anterior field. It is sometimes possible in border-line cases to proceed with small doses of radiation in order to avoid a complete obstruction by the accompanying edema and thus reduce the stenosis and improve the general condition while treatment is progressing. The dose is later increased according to the tolerance of the patient. It goes without saying that these patients must be hospitalized if the treatment is to be conducted with the least risk. Only then is it possible to save all their strength for the treatment, to insure a high-caloric diet, and to administer sufficient fluids for the improvement of their general condition. If the treatment is conducted successfully, the patient's weight will increase and his strength will improve while he is under treatment. That much we have learned by the few cases we were able to treat.

On the basis of this very limited experience, together with our previous experience with 200-kv. radiation, we feel confident that an improvement of technic will, in all likelihood, enhance the curability of

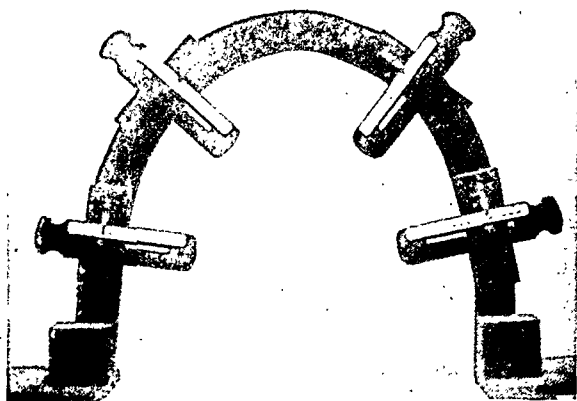


Fig. 13. Localizer for oblique fields.

carcinomas of the esophagus in its intrathoracic portion. We believe that this should be one of the main fields in which supervoltage therapy will have definite advantages over medium voltage both for theoretical reasons and because of the results and limitations of 200-kv. radiation therapy observed in our practical experience. It seems to us that the outlook for carcinoma of the esophagus is more favorable than for carcinoma of the bronchus, since an esophageal cancer usually produces symptoms in a fairly early stage, while patients with bronchiogenic carcinoma almost always have regional lymphatic metastases by the time the primary lesion can be clinically recognized.

It will probably be possible by improved technic and increasing experience to cure a certain number of those intrathoracic esophageal carcinomas which are not yet accompanied by lymph node metastases. Whether we will ever be able to cure carcinomas with lymph node metastases in the mediastinum seems extremely doubtful. Even for palliative purposes, as for temporary improvement of a stenosis in order to avoid gastrostomy, we feel, on the basis of our limited experience, that supervoltage treatment is superior to treatment at 200 kv. It is better tolerated and has considerably less influence on the patient's general condition than treatment at lower voltages.

In concluding, we wish again to emphasize that radiation therapy of carcinoma of



the esophagus should be attempted only if there is reasonable hope for either satisfactory palliation or permanent cure, only in those patients whose general condition is good enough to support a procedure of this magnitude, and only when the external circumstances are sufficiently favorable for adequate clinical supervision. Radiation therapy of carcinoma of the esophagus requires a skillful clinical evaluation of all possibilities, including a careful appraisal of the patient's general condition and the condition of his circulatory organs. In other words, it is a clinical as well as a technical procedure.

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#### BIBLIOGRAPHY

1. BAUM, S. M.: Esophageal-Gastric Carcinoma Successfully Treated by Protracted Fractional X-Ray (Six-Year Survival). *Radiology* 27: 58-62, July 1936.
2. MERRITT, E. A.: Radiation Therapy of Inoperable Intra-Abdominal Malignancy with Special Reference to the Stomach. *Am. J. Roentgenol.* 36: 324-330, September 1936.
3. NIELSEN, J.: Klinische Versuche zur Strahlenbehandlung des Speiseröhrenkrebses. *Acta radiol.* 21: 352-367, 1940.
4. POHLE, E. A.: Radiation Therapy in Carcinoma of Esophagus, with Report of Case Free from Recurrence Seven Years after Treatment. *Mississippi Valley M. J.* 64: 45-48, March 1942.
5. STRANDQVIST, M.: Transthoracic Roentgen Treatment of Cancer of the Esophagus. *Acta radiol.* 22: 172-193, 1941.
6. WATSON, W. L., AND URBAN, J.: Million Volt Roentgen Therapy for Intrathoracic Cancer: Palliative Effects in a Series of 63 Cases. *Am. J. Roentgenol.* 49: 299-306, March 1943.
7. ZUPPINGER, A.: Die Behandlung der Ösophaguskarzinome: Zürcher Erfahrungen. *Ergebn. d. med. Strahlenforsch.* 7: 389-456, 1936.



# The Place of the National Cancer Institute in the Cancer Program<sup>1</sup>

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## GENESIS

THIRTY years ago professional and lay groups in the United States joined hands to launch the American Society for the Control of Cancer, a movement which had as its objective the education of physicians and the public to an effective understanding of the primary importance of early diagnosis and prompt, expert treatment of cancer. Supported by the American Medical Association and the American College of Surgeons, this movement has succeeded beyond all expectations. It was climaxed, we believe, in the passage of the National Cancer Institute Act of August 5, 1937. The Women's Field Army of the American Society has grown until there are now well organized units with commanders and subordinate personnel in 46 of the 48 states.

Twenty-three thousand voluntary workers have distributed more than four million pieces of literature giving information about cancer. An enlightened public has been made cancer-conscious and has now sensed that the fight against cancer, like that against mental disease, tuberculosis, and syphilis, requires something more than the medical care administered to the private patient by the private physician under a strictly confidential relationship. It has realized that education alone is not enough. If our incomplete knowledge of the cause, diagnosis, and treatment of cancer is to be increased, painstaking and carefully planned research must be continued and expanded. Furthermore, if the immediate cancer victim is to receive adequate modern treatment, expensive tools, special equipment, organized

cancer services, and physicians highly trained in tumor surgery, tumor pathology, and in radiology are essential. This is the background of activities which cleared the way for the passage of Federal legislation. It was therefore not surprising that the National Cancer Institute Act received almost universal social approval. This was attested by the fact that 96 members of the United States Senate attached their names to the bill creating the National Cancer Institute as a division of the United States Public Health Service. Never in the history of the republic had the entire membership of either body of Congress sponsored a piece of legislation! Thus cancer was recognized as a national medico-socio-economic health problem.

## THE NATIONAL ADVISORY CANCER COUNCIL

Under the provisions of the National Cancer Institute Act, a National Advisory Cancer Council was created, consisting of six members selected from the ranks of medical and scientific authorities who are outstanding in the study, diagnosis, or treatment of cancer, or in related fields, in the United States. The Surgeon General of the United States Public Health Service acts as chairman of the Council, *ex officio*.

The Council is authorized by the act:

(a) To review research projects or programs submitted to or initiated by it relating to the study of the cause, prevention, or methods of diagnosis and treatment of cancer. . . .

(b) To collect information as to studies which are being carried on in the United States or any other country as to the cause, prevention, and methods of diagnosis and treatment of cancer . . . and . . . make available such information through the appropriate publications for the benefit of health agencies and organizations (public or private), physicians, or any other scientists, and for the information of the general public.

<sup>1</sup> Read by title at the Twenty-ninth Annual Meeting of the Radiological Society of North America, Chicago, Ill., Dec. 1-2, 1943.

<sup>2</sup> Chief, National Cancer Institute, National Institute of Health.

(c) To review applications from any university, hospital, laboratory, or other institution, whether public or private, or from individuals, for grants-in-aid in the case of such projects which show promise. . . .

(d) To recommend to the Secretary of the Treasury for acceptance conditional gifts pursuant to section 6. . . .

#### TRAINING IN DIAGNOSIS AND TREATMENT

Section 5 (b) of the National Cancer Institute Act authorizes the Surgeon General:

To provide the necessary facilities where training and instruction may be given in all technical matters relating to diagnosis and treatment of cancer to such persons as in the opinion of the Surgeon General have proper technical training and shall be designated by him for such training. . . .

Fifty-six young physicians who expressed a special interest in cancer therapy, and who were carefully selected from a large number of applicants, have been given postgraduate training in tumor diagnosis and treatment under the provisions of this section of the act. The men receive one, two, or three years' training, according to their individual needs. Not all institutions are equipped and staffed or have access to sufficient clinical material to give the very highest type of training desired, but there are some, such as Memorial Hospital in New York City, where the training is well organized and where each trainee functions as a junior member of the staff and devotes one year each to tumor surgery, tumor pathology, and radiation therapy. Practically all these men take the training course with the view of subsequently becoming diplomates of the American Board of Surgery, or Pathology, or Radiology. Upon the completion of training, they are capable of setting up and directing tumor clinics to conform to the standards of the American College of Surgeons. It is becoming more and more evident that modern and adequate cancer therapy can be provided only by the co-ordinated and intelligently guided efforts of highly trained experts in surgery, pathology, and radiology. Even if these cancer trainees go into private prac-

tice after completing the course, they are certainly more valuable as practitioners because of their training than they would have been without it. This is particularly true in small communities where there are no tumor clinics. We believe that this selection and postgraduate training of young physicians who have displayed a special interest in cancer therapy is one of the most effective means of rendering assistance to the immediate cancer victim.

#### LOAN OF RADIUM

The National Cancer Institute has purchased 9.3 gm. of radium. Approximately 8.0 gm. has been loaned to various hospitals throughout the country for the treatment of patients. The loan regulations require that this radium be used for treatment purposes only by persons whose qualifications are the equivalent of the standards established by the American Board of Radiology. No charge is made for the use of this radium, and preference must be given to indigent patients. At present 47 hospitals are enjoying the advantages of the Government-owned radium.

#### STATES RELATIONS

The Cancer Institute Act authorizes and directs co-operation with state health agencies in the prevention, control, and eradication of cancer. Accordingly, there was established an office in the National Cancer Institute which studies state cancer-control legislation and activities and provides consultation service to health agencies requesting such aid.

The programs of the various states vary in scope. In general state activities may be classified under the following broad headings: (1) provision of free or part-pay state aid for diagnosis and treatment of cancer patients; (2) free tissue diagnosis; (3) lay and professional education; (4) statistical and epidemiologic research, including a system of follow-up of cancer cases.

At least two states (New York and Massachusetts) participate in all of these

activities, while others carry on only one or two of them. Twelve states have a division of cancer control and a full or part-time director within the state health department. Three states (Missouri, New Hampshire, and Vermont) have state cancer commissions independent of the respective state boards of health. We do not think it wise, as a rule, to separate state health activities and would not recommend independent divisions to states contemplating cancer-control legislation. The problem is, of course, not the same in sparsely populated rural states as in thickly settled industrial and urban areas. Massachusetts and New York each spend over a half million dollars annually on their cancer programs. A few states spend nothing at all.

#### CANCER HEALTH EDUCATION

The National Cancer Institute has collaborated with the American Society for the Control of Cancer in the preparation of educational films and posters. Under the law, the Institute is authorized to make available information about cancer through appropriate publications for the benefit of health agencies, physicians, and scientists, and the general public. Under this authority, cancer education becomes an integral part of the general program of health education of the United States Public Health Service.

In cancer health education, periodic physical examinations, early diagnosis, and prompt treatment have been stressed for a long time. Even today we can add little to what Celsus, at the dawn of the Christian era, wrote: "Only the beginning of a cancer admits of a cure; but when 'tis once settled and confirmed, 'tis incurable and the patient must die under a cold sweat." This means that every cancer passes through a curable stage. It may also be said that *when* cancer is treated is more important than *how* it is treated, provided the patient is in competent hands. Indeed, it has been estimated that at least one-fourth of the 163,000 annual deaths from cancer in the United States could be

prevented if physicians and the public took full advantage of our present knowledge of the disease. The recent establishment of cancer-prevention clinics in New York, Philadelphia, and Chicago bids fair to be an important step in cancer control. The American Society for the Control of Cancer has reported that "in New York City, of 1,500 women examined in 2 prevention clinics, 7 per cent have been found to have early cancer. Ninety-eight per cent of these women are alive and show no signs of recurrence after suitable treatment." These prevention clinics will, we believe, rapidly increase in number in the postwar period.

#### RESEARCH ACTIVITIES

Under its authorization to review and recommend applications for grants-in-aid, the National Advisory Council during the past five years has recommended that over \$400,000 be paid to various institutions for research upon various approaches to the cancer problem. Large sums have been given to the University of California and a smaller amount to Washington University for support of the construction of cyclotrons. These expensive instruments produce the well publicized neutron rays and the radioactive "tracer" elements, both of which are being widely employed in experimental biology and medicine.

Inasmuch as cancer of the stomach accounts for about 25 per cent of all deaths from cancer, a co-ordinated effort has been made by the Council to encourage the investigation of the causes, diagnosis, and treatment of gastric cancer through substantial grants to certain carefully selected institutions, where facilities and expert personnel seem to warrant such studies. These investigations involve the relationship of chronic gastritis, atrophic gastritis, and gastric ulcer to the genesis of gastric cancer, and also studies to facilitate the early diagnosis of cancer by means of the gastroscope and improved gastroscopic technics. As yet it is too early to evaluate these researches. Clear-cut results cannot be expected in a short time.

Research at the National Cancer Institute proper is not departmentalized. There are no subdivisions of biochemistry, biophysics, genetics, cytology, etc., but we do have men on the staff highly trained in each of these various disciplines. Staff members work together in groups according to the need and requirements of a specific problem. Such a group is not like a "committee"—seldom has a "committee" discovered anything. Our staff members work separately at their own benches with their hands, but at the same time they work together with their heads in discussion groups when results and experiences are pooled.

It is believed that cancer research, like cancer therapy, can no longer be left exclusively to the isolated individual worker. In fact, it has been stated by a prominent cancer investigator that for the past two decades no important contribution to our knowledge of cancer has come except through the efforts of those who have worked systematically as members of organized research groups. We believe strongly in responsible co-operative efforts which arise spontaneously in response to the felt needs of the individual workers in contrast to enforced co-operation or regimentation from the top. Effective and productive co-operation in research can be secured best through mutual consent and mutual need.

#### STUDIES IN CARCINOGENESIS

Since 1939, when the National Cancer Institute building was completed and occupied, our more significant research achievements have been in the field of carcinogenesis. The transition of normal cells to cancer cells has been carefully followed *in vivo* and *in vitro*. In both instances, carcinogenesis was brought about without visible evidence of inflammation of any sort.

The evidence also seemed to suggest that the transition is gradual. Grady and Stewart (1), of our staff, injected methylcholanthrene or 1,2,5,6-dibenzanthracene subcutaneously into inbred strain A mice.

Eighty-five per cent of the mice of this strain will develop lung tumors spontaneously at the age of eighteen months. By killing some of the animals each week and carefully studying the histology of the lung, it was found that the first microscopic evidence of tumors appeared in five and six weeks after inoculation. The tumors arose from the alveolar epithelium and not in the bronchi. They were not associated with any inflammatory reaction.

Shimkin (2) has shown that, despite the presence of chronic irritation induced with a single injection of 5 mg. of four metallic ores including quartz (particle size 1.6 to 3.5 micra), no pulmonary tumors were induced in strain A mice within six months after administration. The intravenous injection of these ores did not increase the number of primary pulmonary tumors, nor did it apparently have any other effect upon the development of such tumors following the intravenous injection of 20-methylcholanthrene.

By following the *in vitro* transition, also, of normal to cancer cells, it is believed that a great deal more light has been thrown on the mechanism of the cancer process. It has been known for many years that certain chemicals when injected into experimental animals would induce tumors. It was not known whether these chemicals induced cancer by a direct action on the cell or indirectly by first setting up some unknown systemic condition or chemical imbalance, which finally brought about malignant growth. If the action is direct, what is the nature of the change from a normal to a malignant cell?

Earle (3) has grown normal mouse connective-tissue cells (fibroblasts) in flasks, following essentially the Carrel technic. These tissue-cell cultures multiply in an entirely foreign culture medium and receive no materials whatever from mice. Thus removed from all systemic influences of the mouse, they were subjected to treatment with 20-methylcholanthrene in different concentrations and for different times. These studies have not been completed, but the following conclusions al-

ready seem to be justified: (1) Normal connective-tissue cells grown artificially outside the animal body in the presence of small amounts of methylcholanthrene change over to malignant cells, as determined by the induction of typical cancers following injection of the cells into mice of the same strain from which the cells were originally obtained. (2) The transition is accompanied by certain changes in morphology of the fibroblasts, and also in physiologic behavior as measured by enzyme and metabolic determinations. (3) These changes take place gradually, and the degree of the change can be controlled by the time of exposure of the cell cultures to the carcinogenic agent.

If these results can be repeated, it means that the transition of a normal to a cancer cell can be brought about by means of changes in the cell itself and is not dependent upon systemic factors. These results with tissue cultures seem also to exclude bacteria as causative agents in the genesis of cancer, although they do not exclude the activation of a latent tissue virus. Up to the present, however, there is no convincing evidence of the presence of filtrable virus agents in mammalian cancer cells.

Experiments with carbon tetrachloride seem to throw further light on the mechanism of carcinogenesis. Earlier work of Edwards and Dalton (4) showed that when 0.12 c.c. of carbon tetrachloride was administered to strain A mice in three doses no hepatomas resulted; but when this total quantity was given in twenty-five doses, two or three days apart, hematomas developed in an appreciable number of animals. Subsequently, Eschenbrenner<sup>3</sup> found that when carbon tetrachloride was fed daily to a group of strain A mice for thirty days, no hepatomas developed. Other groups of mice were given the same total dosage, but one group received successive doses every second day, another group every third day, another every fourth day, and the last group every fifth day. Of those that received the carbon

tetrachloride every fourth or fifth day, a high percentage had hepatomas. It was found, in addition, that varying the size of successive doses so that the largest was 16 times the smallest had no effect. Thus it seemed that the dosage interval or longer chronicity of exposure to the agent was more important in the genesis of this type of liver cancer than was the total dosage. In those animals in which the hepatomas had developed, carbon tetrachloride, when again administered, produced no necrosis of the hepatoma cells, but definite and widespread necrosis was observed in the normal liver cells from which the cancer cells arose. In view of this, one can say that the genesis of cancer of the liver in mice seems to be intimately associated with the process by which cells become adjusted to unfavorable environments. The role of the adjustment process, however, is not so clearly seen in cancers following single injuries or exposures. Nevertheless, it may be present.

Henshaw<sup>4</sup> has shown that the incidence of leukoses has been increased in three different strains (C3H, C57 Brown, and C57 Black) of inbred mice by whole-body exposure to 200-kv. x-rays. Such increase was obtained by single acute doses of 200 to 400 r, but even greater increases were obtained by repeating the treatments at intervals of one month. Blum, Grady, and Kirby-Smith (5) have shown that when mice are irradiated with ultraviolet light, the tumor-induction time does not vary significantly with intensity of radiation, but it is shorter when the same total dose is given in smaller, more frequent exposures.

In this same connection, the writer (6) has shown that, when various strains of bacteria are permitted to multiply continuously by daily transfers and are kept at temperatures well above the optimum, the species becomes gradually weaker and finally dies. On the other hand, when the organisms are exposed alternately rather than continuously to the same high

<sup>3</sup> Material not yet published.

<sup>4</sup> Unpublished work.

temperatures, the species not only survives but is soon able to withstand higher temperatures. The alternating exposure has thus resulted in a successful adjustment to an unfavorable environment.

Is the genesis of cancer always the result of a process of successful adjustment of cells to some unusual environmental condition? This question cannot be answered at present with any degree of finality, but all of the observations cited seem to fit in with this concept.

The National Cancer Institute has only lately undertaken investigations in the field of cancer therapy. Some work is also being done along the line of development of reliable diagnostic tests in the early stages of the disease, but no outstanding results have yet been achieved. Our studies in carcinogenesis are regarded as basic because they may eventually lead both to diagnostic methods and rational therapy. Other approaches to the problem, such as the role of vitamins and other nutritional factors in cancer and in normal tissue, the

role of hormones and of enzymes, and the characterization of the metabolism of normal and of cancer tissue, are, of course, being followed. Time and space do not permit a detailed discussion of these activities at the present time.

National Cancer Institute  
Bethesda, Md.

#### REFERENCES

1. GRADY, H. G., AND STEWART, H. L.: Histogenesis of Induced Pulmonary Tumors in Strain A Mice. *Am. J. Path.* 16: 417-432, July 1940.
2. SHIMKIN, M. B., AND LEITER, J.: Induced Pulmonary Tumors in Mice. III. The Role of Chronic Irritation in the Production of Pulmonary Tumors in Strain A Mice. *J. Nat. Cancer Inst.* 1: 241-254, October 1940.
3. EARLE, W. R.: Production of Malignancy *in vitro*. *J. Nat. Cancer Inst.* 4: 131 *et seq.*, October 1943.
4. EDWARDS, J. E., AND DALTON, A. J.: Induction of Cirrhosis of the Liver and of Hepatomas in Mice with Carbon Tetrachloride. *J. Nat. Cancer Inst.* 3: 19-41, August 1942.
5. BLUM, H. F., GRADY, H. G., AND KIRBY-SMITH, J. S.: Relationships between Dosage and Rate of Tumor Induction by Ultraviolet Radiation. *J. Nat. Cancer Inst.* 3: 91-97, August 1942.
6. SPENCER, R. R., AND MELROY, M. B.: Effect of Carcinogens on Small Organisms. IV. Exposure of Bacteria to High Temperatures. *J. Nat. Cancer Inst.* 3: 1-5, August 1942.



## CASE REPORTS

### Traumatic Hernia of the Lateral Pharyngeal Walls<sup>1</sup>

CAPT. WALTER D. HANKINS, M.C., A.U.S.

The following case is recorded because of its unique character. A search of the medical literature failed to reveal any similar example.

Wm. C. W., a 26-year-old sergeant, a trumpet player in the regimental band, was admitted to the Station Hospital, Fort Banks, Mass., for psychiatric study.

had noticed a bulge at this point when he played. Each time after blowing on his instrument, his neck would be sore and swallowing would become painful. He had a horseshoe-shaped piece of metal made with pads on each side which fitted around his neck to keep the muscles from herniating, but this afforded only slight relief.

When the patient blew against pressure, radiographic and fluoroscopic examination showed the hypopharynx filled with air and a bulge of the neck muscles laterally. The piriform sinuses were filled with air and the weakened muscular walls bulged laterally on both sides above the level of the larynx. The right side was dilated more prominently. The lateral walls of the pharynx were outlined with

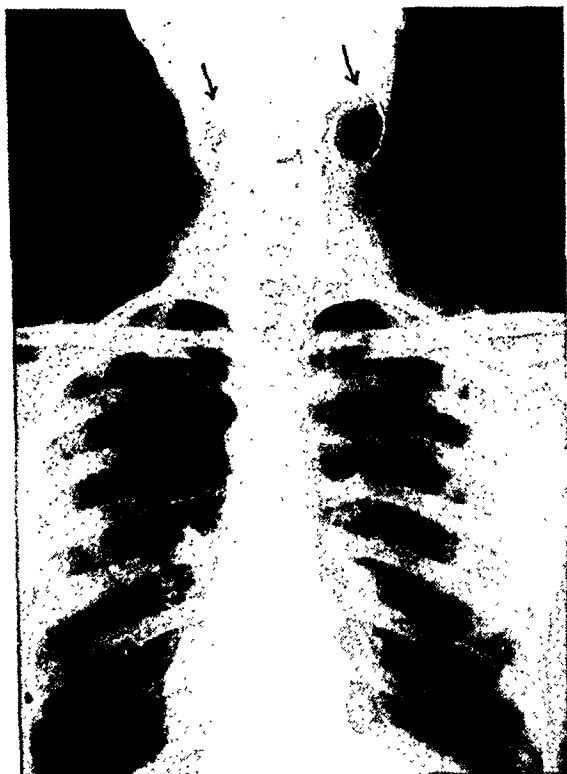


Fig. 1. Anteroposterior view showing dilated lateral walls of the pharynx outlined with barium.

An incidental but interesting finding was a bulge, the size of an egg, in the right cervical region, just below the angle of the mandible, appearing when the patient closed his mouth and blew, as in playing a trumpet.

About six months prior to admission, while blowing his trumpet, the patient felt something "give way" in the right side of his neck. Ever since he

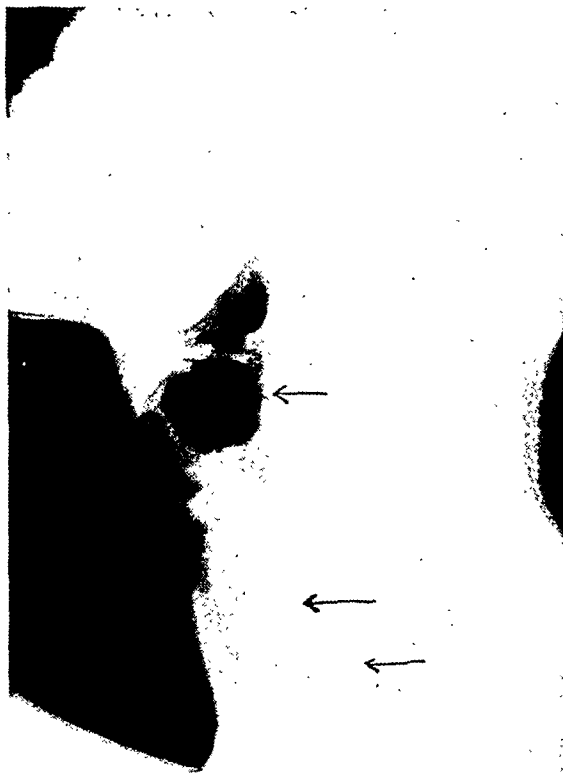


Fig. 2. Lateral view. Upper arrow indicates air in dilated pharynx; middle arrow tracheal dilatation posteriorly; lower arrow apex of the lungs above the level of the clavicles.

barium. The posterior wall of the trachea, just below the larynx was also weakened and bulged posteriorly upon the esophagus. The apices of the lungs rose above the clavicles and in the lateral view can be seen superimposed on the lower portion of the trachea.

<sup>1</sup> From Station Hospital, Fort Banks, Mass. Accepted for publication in September 1943.



# EDITORIAL

Howard P. Doub, M.D., Editor

John D. Camp, M.D., Associate Editor

## Osteoid-Osteoma

The term osteoid-osteoma was introduced in 1935 by Jaffe (1) to designate a "benign osteoblastic tumor composed of osteoid and atypical bone," formerly undescribed. He reported, at that time, 5 cases, all of them diagnosed preoperatively as inflammatory lesions—chronic osteomyelitis or bone abscess—and discussed the clinical, roentgenologic, and pathologic features by which the newly discovered tumor might be recognized.

Even before the publication of his original communication, Jaffe encountered further cases, and by 1940 the number had increased to 33. These form the basis of a paper by Jaffe and Lichtenstein, (2) representing their experience up to that time. It was clearly shown that the disease has a predilection for adolescents and young adults. Age records were available for 30 patients and all but 5 of these were between eleven and twenty-four years of age. The lesions were found in the bones of the limbs and of the vertebral column, but none was encountered in the flat bones of the pelvis, skull, or ribs.

Jaffe's early impression was that the osteoid-osteoma began its development in spongy bone, and his original paper carried a statement to that effect. His subsequent experience, however, showed that it may also have its origin in the cortex, more especially on the periosteal or medullary surface. Lesions originating in spongy bone show an associated area of perifocal osteosclerosis; they may lie deep in the bone or may be more superficial, especially in the small bones consisting mainly of spongiosa. In such cases the cortical shell may be eroded and the periosteum elevated. When the osteoid-osteoma arises

in the cortex, there is usually a more extensive reaction. Developing along the outer surface of the cortex, the lesion may be accompanied by a marked periosteal reaction, with a considerable deposition of new bone. When it develops on the medullary surface, there is also new bone formation, sometimes of such degree that the marrow cavity is obliterated for some distance above and below the lesion. An occasional case appears to be periosteal in origin with little reaction in the underlying cortex.

In the series studied by Jaffe and Lichtenstein the principal complaint was of pain, and it was this that usually brought the patient to a physician. At first mild and periodical, it later increased in persistence and severity so as to interfere with sleep. There were usually some swelling and tenderness over the painful area. There was an absence of local heat and redness which was all the more noticeable because most of the cases were thought clinically to have an inflammatory basis, such as chronic osteomyelitis.

Jaffe and Lichtenstein believe that the diagnosis is not difficult. It should be suspected if (1) the patient is an adolescent or a young adult, (2) the complaint is of well localized bone pain of at least two months' duration, (3) the pain is not associated with local heat, although some local swelling may be present, (4) the condition is not, and has not been, accompanied by bouts of fever.

The greatest single diagnostic aid is the roentgenogram of the affected area. In its earlier course the lesion is indicated by an area of bone radiolucency, which may vary in diameter from 0.5 to 2.0 cm.,

with an average of 1.0 cm. It is likely to be round if situated in spongy bone and oval if in the cortex of a long bone. It is usually surrounded by a zone of reaction which may range from a slight increase in bone density to a dense shadow with loss of all details of bone structure. This area of density may vary in width from a narrow ring to one several centimeters in width. In the cortex of a long bone it may be demonstrable for several inches above and below the area of lessened density and may extend around the circumference of the affected shaft.

In its later stages the osteoid-osteoma tends to become more densely calcified and the appearance is less uniform. In a spongy bone area it is likely to appear as a dense circular circumscribed shadow, often surrounded by a narrow zone of lesser density. In the shaft cortex of a long bone the density of the secondary reaction may be so great that the opaque nidus representing the primary lesion may be missed on an ordinary exposure and an overexposed film of the area may be necessary for its demonstration.

Jaffe and Lichtenstein believe that the osteoid-osteoma is a benign osteogenic tumor of slow growth. Its initial stage appears to be a proliferation of the local bone-forming mesenchyme, particularly of its osteoblasts. Considerable intercellular substance subsequently develops between the osteoblasts and, as this slowly calcifies, numerous osteoid trabeculae appear. Later the tumor becomes more densely calcified and eventually is composed of compact trabeculae of atypical bone, the intertrabecular tissue of which is vascular and may still be rather cellular in some places. Ultimately the osteoma aspect is more prominent than the osteoid aspect.

Surrounding the osteoid-osteoma in spongy bone there is usually a narrow zone of vascular connective tissue, which in turn is surrounded by dense osseous tissue. The trabeculae composing this are thick and irregular and interspersed with fibrous marrow. In the shaft cortex the reaction may be extensive, the thickened cortex con-

sisting of two layers—one representing the original cortex and around this a layer of compact newly deposited periosteal bone.

Since the publication of Jaffe's original paper, a number of reports of this lesion have appeared in medical literature. Horwitz (3) in 1942 described a typical osteoid-osteoma of the astragalus. A case involving the femur was presented by Kleinberg (4) in 1941. In this instance the nidus was entirely within the cortex. A case record from the Massachusetts General Hospital (5) describes an osteoid-osteoma of the tibia at the junction of the upper and middle thirds. These are only a few examples of a growing literature on the subject.

Surgery is the usual method of therapy. Resection of the lesion, with curettage of the perifocal bone, has effected prompt clinical cure in these cases.

If the contention of Jaffe that this lesion is a benign bone tumor is upheld by further study, it is entirely probable that many cases which have been diagnosed as inflammatory bone lesions have been in reality neoplastic—*i.e.*, osteoid-osteomas. This is especially true of those cases which have been designated "sclerosing non-suppurative osteomyelitis," "osteomyelitis with cortical bone abscess," etc. It will be well for the radiologist to study carefully the clinical and roentgenologic findings in cases presenting the criteria described, to the end that these may be correlated with the pathologic findings and a general agreement may be reached regarding the nature of this lesion.

#### BIBLIOGRAPHY

1. JAFFE, H. L.: "Osteoid-Osteoma." A Benign Osteoblastic Tumor Composed of Osteoid and Atypical Bone. *Arch. Surg.* 31: 709-728, November 1935.
2. JAFFE, H. L., AND LICHTENSTEIN, LOUIS: Osteoid-Osteoma: Further Experience with This Benign Tumor of Bone, with Special Reference to Cases Showing the Lesion in Relation to Shaft Cortices and Commonly Misclassified as Instances of Sclerosing Non-Suppurative Osteomyelitis or Cortical Bone Abscess. *J. Bone & Joint Surg.* 22: 645-682, July 1940.
3. HORWITZ, THOMAS: Osteoid-Osteoma of the Astragalus. *Radiology* 39: 226-228, August 1942.
4. KLEINBERG, SAMUEL: Osteoid Osteoma of the Femur: Report of a Case. *Am. J. Surg.* 53: 168-171, July 1941.
5. Osteoid Osteoma of the Tibia. (Cabot case 27492.) *New England J. Med.* 225: 920-922, Dec. 4, 1941.

## ANNOUNCEMENTS AND BOOK REVIEWS

### JOINT MEETING AMERICAN ROENTGEN RAY SOCIETY and RADIOLOGICAL SOCIETY OF NORTH AMERICA

Attention is again called to the joint meeting of the American Roentgen Ray Society and the Radiological Society of North America to be held in the Palmer House, Chicago, Sept. 24 to 29, 1944, announcements of which appeared in the March and April issues of RADIOLOGY.

Titles and abstracts of papers to be presented should be submitted to Dr. Lyell C. Kinney (1831 Fourth Ave., San Diego 1, Calif.) or Dr. Eldwin R. Witwer (Harper Hospital, Detroit 1, Mich.) before July 1. Prospective commercial exhibitors should make application for space to Dr. Lawrence Reynolds (10 Peterboro, Detroit 1, Mich.), and those planning to present scientific exhibits should communicate with Dr. Clarence Hufford (421 Michigan St., Toledo 2, Ohio) at the earliest possible date.

An outline of the Refresher Courses, which will begin Sunday, Sept. 24, will appear in an early issue of RADIOLOGY.

### CHICAGO ROENTGEN SOCIETY

At the Annual Meeting of the Chicago Roentgen Society, April 13, 1944, the following officers were elected: President, Warren W. Furey, M.D.; Vice-President, T. J. Wachowski, M.D.; Secretary-Treasurer, Fay H. Squire, M.D. (Presbyterian Hospital, 1754 W. Congress Street, Chicago 12); Trustees, Earl E. Barth, M.D., Frank L. Hussey, M.D., and Benjamin D. Braun, M.D.

### In Memoriam

#### JAMES MORTIMER HOFFMAN, M.D. 1900-1944

Dr. James Mortimer Hoffman, of Pensacola, Fla., died on Jan. 19, 1944. Doctor Hoffman was a graduate of Tulane University of Louisiana School of Medicine. He was a member of the Radiological Society of North America, the American College of Surgeons, the Southeastern Surgical Congress, and the South Atlantic Association of Obstetricians and Gynecologists.

#### ONAL ARTHUR SALE, M.D. 1891-1944

Dr. Onal Arthur Sale of Neosho, Mo., died on Jan. 27, 1944. Doctor Sale was graduated from the Medical Department of the National University of Arts and Sciences, St. Louis, in 1917. He was part owner and medical director of the Sale-Bowman Hospital of Neosho. He had been a member of the Radiological Society of North America since 1928.

### Books Received

Books received are acknowledged under this heading and such notice may be regarded as recognition of the courtesy of the sender. Reviews will be published in the interest of our readers and as space permits.

EXPLORACIÓN RADIOLÓGICA DEL BRONQUIO. By S. DI RIENZO. Preface by RICHARD H. OVERHOLT, M.D. A volume of 340 pages, with 417 illustrations. Published by Sebastián de Amorrtu e Hijos, Córdoba 2028, Buenos Aires.

### Book Reviews

ROENTGENOGRAPHIC TECHNIQUE. A MANUAL FOR PHYSICIANS, STUDENTS, AND TECHNICIANS. By DARMON ARTELLE RHINEHART, A.M., M.D., F.A.C.R., Professor of Roentgenology and Applied Anatomy, School of Medicine, University of Arkansas; Roentgenologist to St. Vincent's Infirmary, Missouri Pacific Hospital, and the Arkansas Children's Hospital, Little Rock, Arkansas. A volume of 471 pages with 201 engravings. 3d edition, thoroughly revised. Published by Lea & Febiger, Philadelphia. Price \$5.50.

This is the third edition of a well-established textbook on roentgenographic technic. The general plan remains the same as in the earlier editions, but the text has been thoroughly revised to include the newer developments which have marked the progress of this specialty since the last edition. About 40 pages and 31 new illustrations have been added, increasing the number of pages to 471.

After discussing the construction and mechanics of roentgen-ray machines in general and their operation, the author takes up the general properties of x-rays. A chapter is devoted to the dark-room and another to the description of a basic roentgenographic technic which can be applied to any machine by the use of experimental exposures and charting the results of actual diagnostic exposures.

The latter half of the book is devoted to the procedures used for roentgen studies of the various parts of the body and concludes with a chapter containing sections on foreign body localization, roentgenography in pregnancy, and the examination of discharging sinuses. Numerous illustrations supplement the descriptions in the text.

The book is well printed and bound. It should be of great value to all those interested in producing better films and can be recommended to physicians, technicians, and students.

**PHYSICAL FOUNDATIONS OF RADIOLOGY.** By OTTO GLASSER, Ph.D., Professor of Biophysics and Head of Department of Biophysics, Cleveland Clinic Foundation, Cleveland, Ohio; EDITH H. QUIMBY, Sc.D., Associate Professor of Radiology (Physics), College of Physicians and Surgeons, Columbia University, New York; LAURISTON S. TAYLOR, Ph.D., Chief of X-Ray Section, National Bureau of Standards, Washington, D. C.; and J. L. WEATHERWAX, M.A., Philadelphia General Hospital and Graduate School of Medicine, University of Pennsylvania, Philadelphia. A volume of 426 pages with 95 illustrations and numerous depth-dose tables. Published by Paul B. Hoeber, Inc., New York. Price \$5.00.

The general quality of this book is such that one would hardly think it a wartime publication. The cloth binding is excellent, the paper good, and the printing remarkably clear and neat. The annoying typographical errors with which many present-day books are liberally sprinkled are entirely absent; the only minor slip of this sort which came to our attention is on page 211, where the symbols  $D_n$  and  $D_o$  are interchanged with their definitions.

In subject matter, the book combines an elementary text with a collection of tables useful in radiology. These tables are collections of all of the commonly used constants of radiological calculations for voltages between 44 kv. and 180–200 kv., with some data for higher voltages. Absorption of the general radiation in appropriate filter material, back-scatter and depth dose derived from both skin dose and air dose, protection values of various materials, and the latest values of absorption coefficients, are examples of the material presented in a useful form.

**THE RADIOLOGY OF BONES AND JOINTS.** By JAMES F. BRAILSFORD, M.D., Ph.D., F.R.C.P., F.I.C.S., Hunterian Professor, Royal College of Surgeons, England, 1934–35, 1943–44; First President of the British Association of Radiologists; Radiological Demonstrator in Living Anatomy, The University of Birmingham; Honorary Radiologist to the Queen Elizabeth Hospital, Birmingham; Honorary Radiologist to the Royal Cripples' Hospital and the Warwickshire Orthopaedic Hospital; Radiologist to St. Chad's Hospital, the City of Birmingham Infant Wel-

fare Centres and the Military Hospital, Hollymoor, Birmingham; Consulting Radiologist to the City of Birmingham Hospitals, the Robert Jones and Agnes Hunt Orthopaedic Hospital, the Birmingham Accident Hospital and Rehabilitation Centre, the Birmingham Mental Hospital; Late Radiologist, the Birmingham War Hospitals and Ministry of Pensions Hospitals. Awarded the Robert Jones Gold Medal and Prize of the British Orthopaedic Association, 1927, the Roentgen Prize, 1936. Third Edition. A volume of 440 pages with 404 illustrations. Published by J. & A. Churchill, Ltd., London, 1944. Price 45s. (\$9.00).

Since 1934, when the first edition was published, this book has taken its place among the standard works of reference on the roentgenologist's shelf. No other single volume packs between its covers so much reliable information concerning the roentgenology of the skeleton.

In this, the third edition, much new material has been added and much of the old has been brought up to date. The general plan of the book has not been changed. It is divided into two sections, the first of which deals in detail with each anatomic division of the skeleton and the second with certain abnormalities and diseases from the standpoint of the skeleton as a whole. Some idea of the amount of new material may be gained from consideration of the fact that more than 300 references have been added to the bibliography. The excellent index continues to be one of the features of the book.

Because of wartime restrictions, the publisher has been forced to use a poor grade of paper for those pages on which roentgenograms are reproduced. This not only detracts from the appearance of the book but also causes a certain confusion in the order of the illustrations and drawings, of which there are many, connected with the text, but reproductions of roentgenograms are grouped together on pages of gloss paper and are of necessity out of their regular sequence. This confusion, however, amounts only to a minor inconvenience; the quality of the illustrations continues to be excellent.

Except for the unavoidable lowering of physical quality, the book maintains the high standard of excellence set by previous editions. It is recommended highly for students and roentgenologists alike.

# RADIOLOGICAL SOCIETIES OF NORTH AMERICA

*Editor's Note.*—Will secretaries of societies please cooperate by sending information to Howard P. Doub, M.D., Editor, Henry Ford Hospital, Detroit 2, Mich.

## UNITED STATES

*Radiological Society of North America.*—Secretary, D. S. Childs, M.D., 607 Medical Arts Building, Syracuse, N. Y.

*American Roentgen Ray Society.*—Secretary, Harold Dabney Kerr, M.D., Iowa City, Iowa.

*American College of Radiology.*—Secretary, Mac F. Cahal, 540 N. Michigan Ave., Chicago, Ill.

*Section on Radiology, American Medical Association.*—Secretary, J. T. Murphy, M.D., 421 Michigan St., Toledo, Ohio.

## ARKANSAS

*Arkansas Radiological Society.*—Secretary, J. S. Wilson, M.D., Monticello. Meets every three months and annually at meeting of State Medical Society.

## CALIFORNIA

*California Medical Association, Section on Radiology.*—Secretary, Earl R. Miller, M.D., University of California Hospital, San Francisco, Calif.

*Los Angeles County Medical Association, Radiological Section.*—Secretary, Roy W. Johnson, M.D., 1407 South Hope St., Los Angeles. Meets second Wednesday of each month at County Society Building.

*Pacific Roentgen Society.*—Secretary, L. Henry Garland, M.D., 450 Sutter St., San Francisco. Meets annually during meeting of California Medical Association.

*San Diego Roentgen Society.*—Secretary, Henry L. Jaffe, M.D., Naval Hospital, Balboa Park, Calif. Meets first Wednesday of each month.

*San Francisco Radiological Society.*—Secretary, Martha Mottram, M.D., Suite 1789, 450 Sutter St., San Francisco. Meets monthly on third Thursday at 7:45 p.m., in Toland Hall, University of California Hospital, from January to June; at Lane Hall, Stanford University Hospital, July to December.

## COLORADO

*Denver Radiological Club.*—Secretary, Edward J. Meister, M.D., 366 Metropolitan Bldg. Meetings third Friday of each month at the Denver Athletic Club.

## CONNECTICUT

*Connecticut State Medical Society, Section on Radiology.*—Secretary, Max Climan, M.D., 242 Trumbull St., Hartford. Meetings bimonthly, on second Thursday.

## FLORIDA

*Florida Radiological Society.*—Acting Secretary, Walter A. Weed, M.D., 204 Exchange Building, Orlando.

## GEORGIA

*Georgia Radiological Society.*—Secretary-Treasurer, James J. Clark, M.D., 478 Peachtree St., N. E., Atlanta. Meetings twice annually, in November and at the annual meeting of State Medical Association.

## ILLINOIS

*Chicago Roentgen Society.*—Secretary, Warren W. Furey, M.D., 6844 S. Oglesby Ave. Meets at the Palmer House, second Thursday of October, November, January, February, March, and April.

*Illinois Radiological Society.*—Secretary-Treasurer, William DeHollander, M.D., St. Johns' Hospital, Springfield. Meetings quarterly by announcement.

*Illinois State Medical Society, Section on Radiology.*—Secretary, Fay H. Squire, M.D., 1753 W. Congress St., Chicago.

## INDIANA

*The Indiana Roentgen Society.*—Secretary-Treasurer, Harold C. Ochsner, M.D., Methodist Hospital, Indianapolis. Annual meeting in May.

## IOWA

*The Iowa X-ray Club.*—Holds luncheon and business meeting during annual session of Iowa State Medical Society.

## KENTUCKY

*Kentucky Radiological Society.*—Secretary-Treasurer, Sydney E. Johnson, M.D., Louisville City Hospital, Louisville. Meeting annually in Louisville, third Saturday afternoon in April.

## LOUISIANA

*Louisiana Radiological Society.*—Secretary-Treasurer, Johnson R. Anderson, M.D., North Louisiana Sanitarium, Shreveport. Meets annually at same time as State Medical Society.

*Shreveport Radiological Club.*—Secretary-Treasurer, R. W. Cooper, 940 Margaret Place. Meetings monthly on the second Wednesday, at the offices of the various members.

## MARYLAND

*Baltimore City Medical Society, Radiological Section.*—Secretary, Walter L. Kilby, M.D., 101 W. Read St. Meetings are held the third Tuesday of each month.

## MICHIGAN

*Detroit X-ray and Radium Society.*—Secretary-Treasurer, E. R. Witwer, M.D., Harper Hospital, Detroit. Meetings first Thursday of each month from October to May, inclusive, at Wayne County Medical Society club rooms, 4421 Woodward Ave., Detroit.

*Michigan Association of Roentgenologists.*—Secretary-Treasurer, E. M. Shebesta, M.D., 1429 David Whitney Bldg., Detroit. Meetings quarterly by announcement.

## MINNESOTA

*Minnesota Radiological Society.*—Secretary, John P. Medelman, M.D., 572 Lowry Medical Arts Bldg., St. Paul. Meetings quarterly.

## MISSOURI

*Radiological Society of Greater Kansas City.*—Secretary, Arthur B. Smith, M.D., 306 E. 12th St., Kansas City, Mo. Meetings last Thursday of each month.

*The St. Louis Society of Radiologists.*—Secretary, E. W. Spinzig, M.D., 2646 Potomac St. Meets on fourth Wednesday of each month except June, July, August, and September, at a place designated by the president.

## NEBRASKA

*Nebraska Radiological Society.*—Secretary, F. L. Simonds, M.D., 1216 Medical Arts Bldg., Omaha. Meetings third Wednesday of each month at 6 p.m. in either Omaha or Lincoln.

## NEW ENGLAND

*New England Roentgen Ray Society* (Maine, New Hampshire, Vermont, Massachusetts, and Rhode Island).—Secretary, Hugh F. Hare, M.D., Lahey Clinic, Boston, Mass. Meets monthly on third Friday at Boston Medical Library.

## NEW JERSEY

*Radiological Society of New Jersey.*—Secretary, H. J. Perlberg, M.D., Trust Co. of New Jersey Bldg., Jersey City. Meetings at Atlantic City at time of State Medical Society and midwinter in Newark as called by president.

## NEW YORK

*Associated Radiologists of New York, Inc.*—Secretary, William J. Francis, M.D., 210 Fifth Ave., New York City. Regular meetings the first Monday evening of the month in March, May, October, and December.

*Brooklyn Roentgen Ray Society.*—Secretary-Treasurer, Leo Harrington, M.D., 880 Ocean Ave. Meetings held the fourth Tuesday of every month, October to April.

*Buffalo Radiological Society.*—Secretary-Treasurer, Joseph S. Gianfranceschi, M.D., 610 Niagara St. Meetings second Monday evening each month, October to May, inclusive.

*Central New York Roentgen Ray Society.*—Secretary-Treasurer, Carlton F. Potter, M.D., 425 Waverly Ave., Syracuse. Meetings are held in January, May, and October, as called by Executive Committee.

*Long Island Radiological Society.*—Secretary, Marcus Wiener, M.D., 1430 48th St., Brooklyn. Meetings fourth Thursday evening each month at Kings County Medical Bldg.

*New York Roentgen Society.*—Secretary, Haig H. Kasabach, Presbyterian Hospital, New York, N. Y.

*Rochester Roentgen-ray Society.*—Secretary, S. C. Davidson, M.D., 277 Alexander St. Meetings at convenience of committee.

## NORTH CAROLINA

*Radiological Society of North Carolina.*—Secretary-Treasurer, Major I. Fleming, M.D., 404 Falls Road, Rocky Mount. Meeting with State meeting in May, and meeting in October.

## NORTH DAKOTA

*North Dakota Radiological Society.*—Secretary, L. A. Nash, M.D., St. John's Hospital, Fargo. Meetings by announcement.

## OHIO

*Ohio Radiological Society.*—Secretary, J. E. McCarthy, M.D., 707 Race St., Cincinnati. The next meeting will be held at the time and place of the annual meeting of the Ohio State Medical Association.

*Cleveland Radiological Society.*—Secretary-Treasurer, Don D. Brannan, M.D., 11311 Shaker Blvd., Cleveland 4. Meetings at 6:30 P.M. on fourth Monday of each month from October to April, inclusive.

*Radiological Society of the Academy of Medicine (Cincinnati Roentgenologists).*—Secretary-Treasurer, Samuel Brown, M.D., 707 Race St. Meetings held third Tuesday of each month.

## PENNSYLVANIA

*Pennsylvania Radiological Society.*—Secretary-Treasurer, L. E. Wurster, M.D., 416 Pine St., Williamsport. The Society meets annually.

*The Philadelphia Roentgen Ray Society.*—Secretary, Robert P. Barden, M.D., 3400 Spruce St., Philadelphia. Meetings held first Thursday of each month at 8:15 P.M., from October to May, in Thomson Hall, College of Physicians, 21 S. 22nd St., Philadelphia.

*The Pittsburgh Roentgen Society.*—Secretary-Treasurer, Reuben G. Alley, M.D., 4800 Friendship Ave., Pittsburgh, Pa. Meetings are held on the second Wednesday of each month at 4:30 P.M., from October to June, at the Pittsburgh Academy of Medicine, 322 N. Craig St.

## ROCKY MOUNTAIN STATES

*Rocky Mountain Radiological Society* (North Dakota, South Dakota, Nebraska, Kansas, Texas, Wyoming, Montana, Colorado, Idaho, Utah, New Mexico).—Secretary, A. M. Popma, M.D., 220 North First St., Boise, Idaho.

## SOUTH CAROLINA

*South Carolina X-ray Society.*—Secretary-Treasurer, Robert B. Taft, M.D., 103 Rutledge Ave., Charleston. Meeting in Charleston on first Thursday in November, also at time and place of South Carolina State Medical Association.

## TENNESSEE

*Memphis Roentgen Club.*—Chairmanship rotates monthly in alphabetical order. Meetings second Tuesday of each month at University Center.

*Tennessee Radiological Society.*—Secretary-Treasurer, J. Marsh Frère, M.D., 707 Walnut St., Chattanooga. Meeting annually with State Medical Society in April.

## TEXAS

*Texas Radiological Society.*—Secretary-Treasurer, Herman Klapproth M.D., Sherman.

## VIRGINIA

*Virginia Radiological Society.*—Secretary, E. Latané Flanagan, M.D., 215 Medical Arts Bldg., Richmond.

## WASHINGTON

*Washington State Radiological Society.*—Secretary-Treasurer, Thomas Carlile, M.D., 1115 Terry Ave., Seattle. Meetings fourth Monday of each month, October through May, at College Club, Seattle.

## WISCONSIN

*Milwaukee Roentgen Ray Society.*—Secretary-Treasurer, C. A. H. Fortier, M.D., 231 W. Wisconsin Ave., Milwaukee. Meets monthly on second Monday at the University Club.

*Radiological Section of the Wisconsin State Medical Society.*—Secretary, Russell F. Wilson, M.D., Beloit Municipal Hospital, Beloit. Two-day annual meeting in May and one day in connection with annual meeting of State Medical Society, in September.

*University of Wisconsin Radiological Conference.*—Secretary, E. A. Pohle, M.D., 1300 University Ave., Madison, Wis. Meets every Thursday from 4 to 5 P.M., Room 301, Service Memorial Institute.

## CANADA

*La Société Canadienne-Française d'Électrologie et de Radiologie Médicales.*—General Secretary, Origène Dufresne, M.D., Institut du Radium, Montreal. Meetings are held the third Saturday of each month, generally at the Radium Institute, 4120 East Ontario Street, Montreal; sometimes, at homes of members.

## CUBA

*Sociedad de Radiología y Fisioterapia de Cuba.*—Offices in Hospital Mercedes, Havana. Meetings are held monthly.

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## THE HEAD AND NECK

**Tuberculosis of the Flat Bones of the Vault of the Skull. A Study of 40 Cases.** C. M. Meng and Y. K. Wu. *Chinese M. J.* 61: 155-171, April-June 1943.

Tuberculosis of the skull is not an unusual disease in those areas where the incidence of tuberculosis is high. From 1926 to 1940 inclusive, more than 70 cases of cranial bone tuberculosis were diagnosed clinically at the Peiping Union Medical College Hospital. Diagnosis was established in 20 cases histologically, in 5 cases by animal inoculation or culture, and in 15 cases by clinical, roentgen, and other laboratory findings. These 40 proved cases were used for statistical study. Twenty-three of the patients were males. Eighty per cent were less than twenty years of age. Local trauma was not found to be an important factor.

The authors believe that primary tuberculosis of the skull is rare. In 85 per cent of their series of 40 cases, active foci were present elsewhere; pulmonary lesions were demonstrable in 18 cases. Coexistent lesions were found in the mandible and other facial bones in 9 cases, in the sternum in 5 cases, the scapula in 4 cases, and the pelvis in 3 cases.

The tubercle bacilli are believed to be blood-borne, lodging in the diploe and then involving both tables of the skull. Occasionally they may invade the bone via the periosteum or the dura. Two clinical types of lesion are described. The circumscribed, perforating, solitary type was most common in this series, occurring in 38 cases. The defects varied from a few millimeters to 2 cm. in diameter, were round, oval, or irregular in form, and contained sequestra or bone sand. The diffuse or infiltrating type of lesion occurred in only 2 cases. This is believed to spread through the diploe, producing multiple perforations. In either type, with perforation of the outer table, a subperiosteal cold abscess forms. This may remain as a small, palpable, firm, non-tender mass for some time, but eventually it may rupture into the subcutaneous tissue and subsequently form a discharging sinus. The dura usually affords excellent protection when the inner table is perforated. No instance of tuberculous meningitis or cerebral tuberculosis was present in this series. The frontal and parietal bones were affected most commonly. In seven cases, a single lesion involved two adjacent bones, indicating that suture lines form no barrier to the disease process.

The onset is invariably insidious, many patients seeking treatment for complaints in areas other than the skull. The swelling is painless unless secondarily infected and is often mistaken for a sebaceous cyst or lipoma. Perforation of the skull may be detected by palpation of its bony edge. If the perforation is complete, through both tables, arterial pulsations transmitted from the dura are palpable or actually visible if the lesion is sufficiently large.

Syphilis offers the most difficult problem in differential diagnosis since neither a positive serological or tuberculin test necessarily rules out the other condition. Negative tests are of definite value.

Roentgenography is a distinct aid in demonstrating bony defects but does not afford a definite diagnosis. The usual picture is that of one or more round or oval, punched-out defects in which a sequestrum or bone sand

may be seen. There may be no peripheral bone reaction or there may be a zone of increased density as much as 2 cm. in width. Although the lesions are usually osteolytic, osteoplastic changes may occur discharging sinuses or secondary infection.

When possible, aspiration, for culture and animal inoculation purposes, and biopsy should be performed to establish a positive diagnosis.

Prognosis depends on the degree of tuberculous involvement and general condition of the patient. In early cases the prognosis may be fair even in the presence of multiple associated lesions.

Local treatment consists of complete excision of the diseased tissues and closure without drainage except when there has been a discharging sinus or ulcer. The dura should not be disturbed. Radiation therapy was used in 3 cases (in 2 postoperatively) with good results and is recommended especially in the larger lesions not suitable for excision.

Photographs and roentgenograms are reproduced.

LESTER M. J. FREEDMAN, M.D.

**Fractures of the Zygoma: Report of 72 Consecutive Cases.** Walter A. Coakley and Malvin F. White. *Surg., Gynec. & Obst.* 77: 360-366, October 1943.

Fractures of the zygoma have been neglected in medical literature in recent years, probably because they are not treated by any one group of specialists, but by various groups in different clinics. This report deals with 72 consecutive cases seen in Kings County Hospital (Brooklyn, N. Y.) from July 1939 to June 1942. In that hospital all such cases are treated by the Plastic and Oral Surgical Service, but only 29 per cent of the series under consideration were originally admitted to that service. Two-thirds of the patients were seen initially in the Neurosurgical Service because of head injuries or for neurological observation. For this reason it is especially important that neurosurgeons be acquainted with this lesion.

Fractures of the zygoma are always due to trauma. In the authors' series 31 cases were due to automobile and trolley accidents, 16 cases to fist blows, 8 cases to falls, 5 cases to a blow from a foreign object; in 12 cases the type of injury could not be determined.

The average age of the group was 32.4 years, the youngest patient being 14 years of age, and the oldest 65. Fifty-seven of the series were males. There were 5 cases of bilateral fracture; but in the remainder the ratio of left to right was almost 3.5:1. These fractures are usually multiple, and in only 4 cases did a single fracture exist. The average was 3 fractures each, the total number of fractures being 207 in the 72 patients. The arch was the most frequent site, with the infra-orbital region coming next.

The most frequent signs and symptoms are as follows: periorbital swelling and ecchymosis, local tenderness, palpable depression or irregularity, pain (either constant or on chewing), asymmetry of the face, epistaxis, and sensory changes over the distribution of the infra-orbital nerve. Almost all of the patients had lacerations and contusions of the face, and many of them had fractures of other facial bones.

All of the patients in this series requiring operation were operated on within two weeks of the injury, and

most of them within the first week. Two methods of approach are used. The first of these is the temporal approach which was used where the arch was depressed. This method is unsatisfactory in those cases in which the force of the blow causes the body of the zygoma to be driven downward and into the antrum with lowering of the infraorbital ridge and multiple depressed fragments of the wall of the maxillary sinus. In these an antral approach was employed, through the vestibule of the mouth, as for a Caldwell-Luc operation. A blunt instrument such as a curved urethral sound of medium size was passed in and the fragments were elevated.

Forty-two patients were operated upon, and hemorrhage, in 2 cases, was the sole complication; in both it was controlled by packing. In 24 cases a temporal approach was used, and in 14 an antral approach; 2 patients required a combination of the two methods. In 8 of the 14 cases in which an antral approach was used, packing was required to maintain the reduction. The patients with no other injuries were discharged one to fourteen days postoperatively.

JOHN O. LAFFERTY, M.D.

**Adamantinoma: Report of 8 Cases.** L. K. Chont Am. J. Roentgenol. 50: 480-490, October 1943.

Eight cases of adamantinoma are here reported, 7 in the jaw and 1 in the pituitary body. In one of the jaw tumors pulmonary metastasis occurred. A review of the literature revealed only 14 other examples of distant or regional metastasis.

Adamantinomas occur most frequently in the jaws. Several cases of pituitary adamantinoma have been recorded and approximately 16 of the tibia. Whatever the origin of the tumor, it can always be traced back to the parent cell, the oral epithelium. Histologically it is composed of groups of epithelial cells in a stroma of normal connective tissue.

Clinically, adamantinoma of the jaw is characterized by its long duration. It is a painless, slowly growing, centrally located tumor which may reach large size. The roentgen examination is very important in establishing the diagnosis. The solid adamantinoma produces a monocystic appearance on the roentgenogram. It usually can be differentiated from other cysts by the more lobulated borders of the bone defect and the presence of a few fine bone trabeculae at the edges of the lesion. The polycystic type has a honeycomb appearance in the early stage, and later is characterized by huge distention of the bone by a cystic defect showing several rounded compartments. An adamantinoma may form a large single cavity resembling a dentigerous cyst but can be differentiated by the appearance of the margin, as noted above.

Roentgenograms of the reported cases are reproduced and a bibliography is appended. L. W. PAUL, M.D.

**Osteoma of the Frontal Sinus. Report of a Case.** W. H. Johnston. Arch. Otolaryng. 38: 318-323, October 1943.

A white woman, 50 years of age, was admitted to the hospital in 1936, complaining of severe headaches. It was thought that pituitary disease might be a factor, and roentgen examination of the sella turcica was made. No consideration was apparently given to the possibility of a sinus condition, and an osteoma, although visible in the roentgenogram then made, was not reported. In August 1942, the patient was again admitted to the hospital, complaining of dizziness and

headaches, which had been increasing in severity over the past three months. On roentgen examination a bony structure was seen almost filling the left frontal sinus, apparently arising from its roof. A diagnosis of osteoma of the left frontal sinus was made and later confirmed at operation. The point of attachment of the tumor was at the extreme upper and anterior wall of the sinus, suggesting activation of a periosteal embryonal rest as the etiologic factor. Comparison of the roentgenograms taken in 1936 and 1942 shows a very slight but perceptible increase in the size of the tumor in six years.

## THE CHEST

**Acute Pneumonitis.** Wendell G. Scott and Horace L. Jones, Jr. Am. J. Roentgenol. 50: 444-452, October 1943.

The diagnosis of acute pneumonitis has become more common in the past two years, largely because of more intensive use of chest roentgenography. Chest roentgenograms were made for 145 of 534 patients admitted to the medical wards at the U. S. Naval Air Station in San Diego with a tentative diagnosis of acute catarrhal fever, which the authors explain is an all-inclusive term covering many types of benign acute upper respiratory infection. Seventy-four of these patients showed areas of pulmonary consolidation of the type referred to as acute pneumonitis.

There is nothing characteristic about the roentgen appearance of the area of pneumonitis that can be considered as pathognomonic of the disease. It is easily identified, however, when occurring in epidemic form among young, robust military personnel. Usually there is an area of hazy density extending out from the hilar region into the lower lung field and occasionally into the mid lung field. Margins are poorly defined in the beginning. As the disease progresses, the area of pneumonitis becomes more dense and larger, with more sharply defined margins. The shape is usually that of a fan or of a rounded area, and the distribution is lobular rather than lobar. With resolution, the density gradually diminishes, and the infiltration becomes mottled, patchy, and more linear in type.

In the authors' series of 74 cases, 52 occurred in the lower and middle lobes, 9 immediately about the hilum, and 5 in the upper lobes; there were 8 cases of bilateral involvement.

The laboratory findings, differential diagnosis, pathological findings, treatment, and clinical aspects of the disease are reviewed and short histories and roentgenograms of 7 cases are furnished. These illustrate the similarity of the cases seen by the authors to those reported by others. The prevalent opinion is that such infections are probably of virus origin and are, therefore, not responsive to chemotherapy. It is probable that many cases are erroneously diagnosed as "grippe," "upper respiratory infection," or "acute catarrhal fever," and that the more frequent use of chest roentgenograms will disclose an even higher incidence of this disease.

L. W. PAUL, M.D.

**Massive Conglomerate Lesions of Silicosis Differentiated from Pulmonary Neoplasm.** Richard A. Rendich and Mortimer R. Camiel. J. Thoracic Surg. 12: 686-696, October 1943.

In a review of the literature 5 cases were found in which the diagnosis of carcinoma of the lung was made

and the condition proved to be silicosis. In one of these cases a pneumonectomy was done. This patient is described as having a unilateral hilar mass demonstrable roentgenographically, with no nodular lesions elsewhere. On the other hand, Pendergrass has stated that infiltrating or permeating malignant metastases may be of such appearance as to resemble pneumoconiosis of a conglomerate type.

The authors report 2 cases diagnosed clinically and roentgenologically as carcinoma of the lung which proved postmortem to be silicosis, one being complicated by tuberculosis. In both instances the lesions were bilateral and somewhat symmetrical, with one mass larger than the other. In addition to the large conglomerate masses, other nodular lesions were also present. The authors point out in retrospect that the diagnosis of pulmonary neoplasm should not have been made in either case and that the roentgen appearance was much more consistent with silicosis.

A table is presented giving twenty-nine points by which conglomerate silicotic lesions can be differentiated from pulmonary neoplasms both clinically and roentgenologically. HAROLD O. PETERSON, M.D.

#### Diverticulum of the Right Primary Bronchus.

José Arce. *J. Thoracic Surg.* 12: 638-641, October 1943.

A case report is presented with reproductions of several roentgenograms illustrating a diverticulum of the right main bronchus arising on a level with the upper lobe bronchus. This was observed by bronchoscopy and also demonstrated by bronchograms. The diverticulum was rather small and connected to the main bronchus by a large opening. The patient had also a hydatid cyst of the right lung, which was removed surgically. The diverticulum was an incidental finding. No review of the literature or bibliography is given.

HAROLD O. PETERSON, M.D.

**Chronic Cor Pulmonale.** Leo G. Rigler and Phillip Hallock. *Am. J. Roentgenol.* 50: 453-460, October 1943.

Cor pulmonale is defined as enlargement of the right side of the heart, with or without failure, initiated by increased resistance to blood flow within the lesser (pulmonary) circulation as a result of pulmonary disease. Such increased resistance to blood flow may be brought about by obliteration of the capillary bed, such as occurs in emphysema or pneumoconiosis, or narrowing of the pulmonary vessels, as in pulmonary arteriosclerosis. Recent studies have indicated that chronic pulmonary heart disease is more common than formerly supposed.

The recognition of chronic cor pulmonale presents many difficulties. The clinician often can only speculate as to the possibility of right ventricular strain unless signs of right heart failure are present. With careful roentgen examination, cardiac involvement in cases of chronic pulmonary disease can be recognized in a large percentage of cases by evidence of enlargement of the right side of the heart. Roentgen studies must be made in all four standard positions. The characteristic findings are due to enlargement of the right ventricle and of the pulmonary trunk. In addition, the major branches of the pulmonary artery may be dilated beyond the normal. Evidences of chronic pulmonary disease may be apparent, such as chronic tuberculosis,

silicosis, bronchiectasis, or emphysema. In the case of primary pulmonary arteriosclerosis, these findings in the parenchyma of the lungs will be absent. In their place will be found a much more striking increase in the size of the pulmonary trunk and its major branches, together with a marked increase in size of the pulmonary vessels extending out to the periphery. These accentuated vessels differ from those seen in pulmonary congestion such as attends left heart failure, by the sharpness of their outlines and the lack of cloudy density in the lung parenchyma.

Differential diagnosis of cor pulmonale is not always simple. Acquired mitral valvular disease produces right heart enlargement, but the pulmonary trunk is usually enlarged to a lesser degree; enlargement of the left atrium is usually obvious, and displacement of the barium-filled esophagus may be noted. In this condition, also, pulmonary congestion rather than real dilatation of the pulmonary arteries is likely to be present, producing a more hazy, ill-defined mottling throughout both lungs as compared with the sharply defined shadows of the pulmonary arteries seen in cor pulmonale. In most congenital defects the differentiation is not difficult, especially if the physical findings are borne in mind. Thus, in the majority of instances of patent ductus arteriosus characteristic murmurs are present, of such a nature as to make the diagnosis apparent when the roentgen findings are taken into consideration. The roentgen examination alone, however, may simulate the picture of right heart failure from pulmonary arteriosclerosis. The heart in hyperthyroidism may tend to simulate right heart enlargement.

L. W. PAUL, M.D.

**Technique for Locating and Identifying Pericardial and Intracardiac Calcifications.** Merrill C. Sosman. *Am. J. Roentgenol.* 50: 461-468, October 1943.

In searching for intracardiac and pericardial calcification, proper technic of examination is essential. Roentgenoscopy is required, and the observer's eyes should be thoroughly accommodated. The observer must look *through* the heart shadow, searching for dark, dancing shadows which move to and fro with systole and diastole.

Pericardial calcifications are visible as flat segments or irregular plaques just inside the heart shadow. By rotating the patient through 180° some point will be found where the calcified areas will be close to the periphery of the heart shadow, indicating their superficial location. A very common location is on the diaphragmatic surface of the pericardium. These shadows move with the heart shadow on respiration and rotation, but may show only slight or no excursion with systole and diastole. This finding always indicates an adhesive pericarditis but not necessarily a constrictive pericarditis.

It is estimated that 10 per cent of patients with rheumatic mitral stenosis will show calcification in the mitral valve roentgenoscopically, while 90 per cent of those with aortic stenosis will show calcified aortic valves on roentgenoscopy. These calcified valves are best demonstrated with the patient in a slight right anterior oblique position and holding a deep breath. After the auriculo-ventricular junction on the left border of the heart has been located, a search should be made *through* the heart on a line 45° from the horizontal from this point downward and medially toward the right cardiophrenic angle. Both valves will be found on

or near this line. As a rule the calcified mitral valve will be found near the apex of the heart and the aortic valve near the base. In the left anterior oblique position, which is especially valuable in differentiating between the two valves, the aortic valve will be found in the middle third of the cardiac shadow and the mitral valve in the posterior third.

The annulus fibrosus of the mitral valve may calcify, appearing as a large J- or U-shaped shadow, as compared to the more irregular nodular shadows of the calcified valve itself. This occurs frequently in elderly persons and is not thought to be of clinical importance.

Calcification in the coronary arteries can be recognized by the technic already described. The most common location is in the circumflex branch of the left coronary, just beneath the pericardium and just below the auriculo-ventricular notch on the left cardiac border. The calcified areas are seen as a faint linear shadow, segmented, with a smooth curve convex upward.

Myocardial calcifications are less common, but massive areas of calcification may occur in old infarcts or old thrombi. These are most frequently found at or near the apex of the heart in the wall of the left ventricle. Endocardial calcification is also rare and its significance is frequently uncertain. Calcification in tumors of the heart has not as yet been recognized by the author during life.

The author adds a brief statement of his own experience covering 294 cases. L. W. PAUL, M.D.

**Atrial Septal Defect: Report of Two Cases in Which There Was Recurrent Laryngeal Nerve Paralysis.** Herman Erlanger and Samuel A. Levine. *Am. Heart J.* 26: 520-527, October 1943.

Two interesting cases of atrial septal defect complicated by recurrent laryngeal nerve paralysis are recorded. In one a diagnosis of patent ductus arteriosus had been made; in the second a substernal thyroid was suspected.

In Case 1, the electrocardiographic examination showed moderate right axis deviation and inverted T waves in Lead IV. The roentgen examination revealed enlargement of the heart, predominantly downward and to the left, marked prominence of the pulmonary conus, dilatation of the intrapulmonary arteries, and slight enlargement of the left auricle posteriorly. Laryngoscopic examination revealed an immobile left vocal cord. The right cord was mobile, crossed the mid-line on phonation, but did not approximate the paralyzed left cord. The left arytenoid cartilage showed no movement on phonation.

In the second case, the electrocardiographic tracing was similar to that in the first. Roentgen examination showed cardiac enlargement, predominantly of the left ventricle, expansile pulsation in a prominent pulmonary artery which projected well beyond the left border of the cardiac silhouette just below the aortic arch, enlarged intrapulmonary branches on the right side, and no demonstrable enlargement of the left auricle. Laryngoscopic examination revealed a paralyzed left cord, but the right cord approximated the left on phonation.

In each case the evidence points to a compression of the recurrent laryngeal nerve between the aorta and the dilated pulmonary artery.

The necessity for accurate diagnosis in congenital heart disease is stressed, especially since a patent ductus arteriosus may call for surgical intervention.

HENRY K. TAYLOR, M.D.

**Anomalous Origins of the Posterior Intercostal Arteries from 915 Thoracic Aortas: Their Role in Fractures of the Ribs.** Myrtelle M. Canavan. *Am. Heart J.* 26: 511-519, October 1943.

The study here recorded of 915 thoracic aortas collected from various institutions was made in an attempt to determine the role of that vessel in fractures of the ribs discovered postmortem in a considerable group of patients in hospitals for mental diseases. These fractures were usually bilateral, involving the fourth to the eighth ribs.

Of the 915 specimens, 473 were from males and 371 from females; for the remaining 71 the sex was not recorded. The majority were from patients in the fourth to the ninth decades, but the lower age groups were also represented. The nine paired intercostal arteries (from the level of the subclavian down to the level of the diaphragm) were found in the normal posterior mid-location in only 231 instances, or 25 per cent of the series (Group I). The remaining aortas (75 per cent) were divided into six groups (II-VII) depending on the prevalent anomaly, as follows: II. Most of the upper vessels arising to the left of the mid-line and the lower ones to the right, 41 or 4.5 per cent. III. Most of the upper vessels arising to the right and the lower ones to the left of the mid-line, 71 or 7.8 per cent. IV. All to the right of the mid-line, 314 or 34.3 per cent. V. All to the left of the mid-line, 168 or 18.4 per cent. VI. All situated anteriorly, 75 or 8.2 per cent. VII. Scattered origins not included in the other groups, 16 or 1.7 per cent.

In 673, or 73.6 per cent of the series, there was an atherosclerosis or arteriosclerosis which narrowed or covered the mouths of the intercostal arteries. In some cases there was a history of alcoholism and in some of syphilis. The pathological changes in the aorta taken in conjunction with the anomalies of origin of the intercostal vessels are believed to have resulted in interference with the nutritional function of the vessels. "If," says the author, "the ribs . . . may be considered to receive their blood supply from the anterior and posterior intercostal arteries, although no text book which I consulted states this as a fact, the majority of them in this group of 915 cases had handicaps." This is regarded as a possible explanation of the perplexing incidence of fractured ribs postmortem which prompted this study.

HENRY K. TAYLOR, M.D.

## THE DIGESTIVE SYSTEM

**Problems in Gastric Diagnosis. The Gastroscope as a Supplementary Aid to X-Ray Examination.** Allan L. Cohn and Joseph Levitin. *Gastroenterology* 1: 841-854, September 1943.

There are definite limitations to the x-ray diagnosis of gastric lesions. Five per cent of early carcinomas are not demonstrable roentgenologically. Only if an ulcer penetrates the mucosa can it be demonstrated; consequently many acute ulcers are missed. There are no sure x-ray criteria for differentiating malignant from benign ulcers, malignant from benign growths, and intrinsic from extrinsic lesions.

Gastrosocopy also has its limitations. There are three blind areas: the lesser curvature of the antrum, the posterior wall near the cardia, and a small area of the mid-portion of the greater curvature. The gastroscope cannot be safely used in the presence of esophageal obstruction, varices, or diverticula, mediastinal tumors or

aneurysm. Its use may be valueless in the presence of lesions of the deeper tissues without mucosal involvement. Gastroscopy, however, often gives information obtainable in no other way. It is especially valuable in the diagnosis of lesions of the mucosa difficult or impossible to detect by roentgenography, as gastritis, granulomata, superficial erosions, and polyps.

In many instances differentiation of the malignant from the benign gastric ulcer is possible roentgenologically. The roentgen appearance of a typical benign ulcer differs from that of the typical malignant ulcer. The essential differential points indicating malignant ulcer are invasion of adjacent tissues, an irregular niche, changes in the surrounding mucosa, and encroachment upon the gastric lumen. Variations in these criteria occur, however, and even a therapeutic test is not infallible.

The gastroscopic appearances, also, differ in benign and malignant ulcers. A benign ulcer appears as a white or yellow smooth depression, round or oval, in an orange red mucosal field. Its edge is quite distinguishable from the surrounding mucosa. A malignant ulcer appears as an irregular depression in the center of an elevation. The floor is irregular, of a dead white, dirty gray, black brown, or purple color. The margin is not sharply defined and may merge into the adjacent mucosa.

Gastroscopy is also useful in distinguishing malignant from benign tumors. It is especially valuable in indicating the extent of a malignant lesion, which cannot be judged from the x-ray appearance. Polyps which are rarely diagnosed by roentgenography can be visualized by gastroscopy and their size and number established.

Gastroscopy is also of great value in determining the origin of gastric bleeding, whether it is due to a surgical condition, requiring immediate attention, or to a non-surgical cause. It renders assistance in differentiating antral spasm from intra- and extra-gastric lesions. Gastritis of both the hypertrophic and atrophic type can be diagnosed only by gastroscopic examination. The status of the stomach postoperatively can be determined more readily by gastroscopy than by x-ray examination.

**Volvulus of the Cecum and Ascending Colon, with a Review of the Literature and Presentation of a Case.** Milton Rothman, John P. Bruckner, and Dominick F. Zetena. *Am. J. Surg.* 60: 292-297, May 1943.

Volvulus of the cecum and ascending colon occurs infrequently. Six cases of volvulus were encountered in the last 150 cases of acute intestinal obstruction at Harlem Hospital (New York). The case reported here is the only one in which the cecum and ascending colon were involved.

Failure of fixation of the colon in the course of embryological development is the underlying cause of volvulus. The predisposing factors are (1) unusual length of the mesentery; (2) narrow base to the loop of the intestine; (3) a point of adhesion, inflammatory or congenital, at the convexity of the loop which can act as an axis of rotation. The following have been suggested as possible precipitating causes: tumors, direct violence, overexertion, habitual constipation, fecaliths, foreign bodies, and violent peristalsis. Volvulus occurs three times more frequently in the male than in the female. It is generally seen between the third and fourth decades of life.

The symptomatology is essentially that of acute in-

testinal obstruction. The progression of symptoms, however, is much more rapid in a closed loop obstruction involving the cecum and ascending colon than in a simple obstruction. Chemical studies reveal an elevation of urea nitrogen and low chlorides. The hematocrit shows hemoconcentration. The diagnosis of a strangulated loop is made on the finding of an intestinal obstruction in association with signs of peritonitis.

Roentgenograms are of assistance in the diagnosis of volvulus of the cecum. This is indicated when, in the course of a barium enema study, the column of barium is unable to pass beyond a certain point distal to the cecum so that the cecum itself cannot be properly delineated in its haustral markings by the barium; at the same time a large collection of gas appears at the site of the cecum, either in the mid-line or slightly to the right. The barium serves to show an obstruction of the large colon, above which distended gut, with or without fluid levels, will be seen.

The authors describe a procedure which they have found of value in the diagnosis of closed loop obstruction, both in the large and small gut. It consists essentially in a comparison of roentgen films made before and after attempts at decompression. These will show the gas bubble in essentially the same position and of the same configuration. If the films are superimposed, no decrease in its size will be found following the attempts at decompression. This points to a closed loop obstruction.

As soon as the diagnosis is made, immediate surgery is indicated, the type of operation depending upon the findings. If the intestines are viable, untwisting, cecostomy and cecopexy are the procedure of choice. If the intestines are gangrenous, a one- or two-stage procedure with resection is indicated.

**Supralelevator Abscess.** Eugene A. Gaston and Lyman O. Warren. *New England J. Med.* 229: 613-619, Oct. 14, 1943.

The authors' experience with a case of supralelevator abscess has led them to describe the condition in an effort to make it better known and understood.

The supralelevator space is that space in the pelvic cavity just above the levator ani muscles, anterior to the sacrum and posterior to the prostate in the male and to the vagina in the female. The route of infection of the supralelevator space is not definitely established, but the most likely origin is from the crypts of Morgagni. Direct trauma has been known to cause this abscess. It may be due to extension upward from the ischiorectal space.

The clinical picture is often confusing. The onset is usually characterized by general malaise, with fever and leukocytosis. After a period of a few days or months, pelvic discomfort and a sense of rectal swelling occur. This discomfort may be relieved temporarily by defecation. Symptoms of low-intestinal obstruction develop. In men, urinary symptoms may occur. Finally localizing signs of abscess formation appear.

The diagnosis is usually established by digital and instrumental investigation. There are high localized tenderness and swelling in one quadrant or the entire circumference of the rectum. Proctoscopically there is definite narrowing of the rectum, with bulging of part of it. Extreme pain may be elicited by firm pressure on the skin between the tip of the coccyx and the anus. The abscess may rupture and spread in a variety of ways and directions.

A barium enema study may show the rectal narrowing and displacement. The condition is to be differentiated from cancer by the intact mucosa. Treatment is by incision and drainage. JOHN B. McANENY, M.D.

### THE SKELETAL SYSTEM

**Ice Skater's Fracture: A Form of Fatigue Fracture.** C. F. Ingersoll. *Am. J. Roentgenol.* 50: 469-479, October 1943.

Fatigue fractures were first recognized in the metatarsal bones and were thought to be confined to these bones because of their peculiar anatomical arrangement. Recently, however, the same type of lesion has been found in other bones such as the femur, tibia, and fibula, where anatomical variations cannot be held responsible. The author reports 3 cases which he describes as "ice skater's fracture" occurring in the lower fibula. They were identical in the following respects: (1) All were in the same location in the lower fibula. (2) Each patient was nine years old. (3) All were boys. (4) The skates were tubular skates in which the attached shoe is elevated by metal tubes above the runner. (5) In each instance the skates were recently acquired.

The term "fatigue fracture" is suggested to denote all of those fractures occurring in apparently normal bone which seem to be due to the summation of microtraumata from repeated subfractural mechanical injury. Pseudofractures are not included in this category, as they are associated with a generalized metabolic disease. The roentgen findings in the author's cases were similar to those that have been described as occurring in march foot or march fracture of the metatarsal, except that the lesion was noted in the lower end of the fibular shaft. In one patient, examination of the other leg for comparison showed a similar lesion, which was without symptoms.

In attempting to explain the cause of these fractures, the author states that there is ample evidence that repeated minor traumata are responsible. The more inexperienced or tired the skater, the greater the eversion of the foot with which he skates. With the foot in eversion the weight-bearing line shifts laterally and runs approximately along the course of the interosseous membrane. This increases the pressure against the lateral malleolus.

Recognition of the nature of these fractures is extremely important, since they may be confused with primary malignant bone neoplasm, as has been done in the past in the case of fractures occurring in the tibia, fibula, and metatarsals. L. W. PAUL, M.D.

**Double March Fracture. A Case Report.** Samuel R. Terhune and Thomas S. Eddleman. *Mil. Surgeon* 93: 310-311, September 1943.

A case of spontaneous fracture of the second and third metatarsals, occurring in a soldier with three months' army service, is reported. The fractures responded well to treatment and recent roentgenograms (after 6 months) show less excessive callus than at the first examination and slightly more thickening of the cortex at both of the fracture sites.

**Treatment and Results in Localized Osteitis Fibrosa Cystica (Solitary Bone Cyst).** A. D. McLachlin. *J. Bone & Joint Surg.* 25: 777-790, October 1943.

According to the present concept of osteitis fibrosa cystica, there are three different forms. The general-

ized form affects the entire skeleton and is due to an adenoma of the parathyroid gland. The regional form shows involvement of one side of the body, one extremity, or a single bone in its entirety. The localized form is the solitary bone cyst.

A bone cyst begins on the metaphyseal side of the epiphyseal line, usually before the age of fifteen, and is most frequently found in the upper femur, humerus, or tibia. Pathological fracture is common and may be the sole factor in the discovery of the lesion. Roentgenographically the cyst is seen to be expansile and limited by the cortex. It may be crossed by trabeculae. It is usually filled with a greenish fluid and has a fibrous wall, in which many giant cells may be found.

This paper is based upon 27 cases of bone cyst. Fracture was the presenting symptom in 17 cases. Five were treated by open operation and 12 by immobilization. Four patients had repeated fractures and required operative interference and in 2 other cases the joint was opened to prevent fracture. Thus immobilization gave satisfactory results in only 6 of the 12 cases. Curettage was done in 11 cases and led to good final results in 10 patients. In one case a second curettage was done and bone slivers were placed in the cavity. Including this case, curettage and packing with bone slivers were done in 11 cases, all with favorable results. Irradiation was used in 2 cases, without noticeable improvement.

The conclusion reached is that in the presence of fracture, the treatment of choice is open operation, which may be done within a few days. Curettage, with packing of the cavity with bone slivers, is the most satisfactory procedure. JOHN B. McANENY, M.D.

**Recent Advances in the Treatment of Ruptured (Lumbar) Intervertebral Disks.** Walter E. Dandy. *Ann. Surg.* 118: 639-645, October 1943.

The author states that in 95 out of 100 cases with a history of low back pain with sciatica down the back of the leg, occurring in attacks and intensified by coughing and sneezing during the acute stage of pain, a diagnosis of ruptured intervertebral disk can be made on the symptoms alone. Spondylolisthesis may cause 2 per cent of the remaining cases, a congenitally defective fifth lumbar vertebra 2 per cent, and tumors of the cauda equina 1 per cent.

Only two examinations are important: (1) roentgenography, which will exclude other lesions and frequently in the lateral view will indicate a ruptured disk by the narrowing of an intervertebral space; (2) determination of the Achilles reflex, which is normal in over half the cases but may be absent or reduced, indicating involvement of the fifth lumbar.

One-third of all intervertebral disks protrude; the remaining two-thirds are concealed. According to the author, spinal injections of lipiodol, air, etc., are strongly contraindicated, as they fail to disclose the concealed disk and are not necessary for diagnosis. Spinal punctures should also be avoided. In the last 400 operations a disk has been missed only once; in this case a tumor was present. In none of these were contrast media used.

In 98 per cent of all ruptured lumbar disks the site is at the fourth or fifth vertebra, which the author believes is due to a shift in the plane of the articular process from the horizontal to a transverse direction. About 20 per cent of all patients with ruptured disks have two—one at the fourth and the other at the fifth lumbar.

Fusion operations are contraindicated. Thorough removal of the entire necrotic content of the interior of the disk with curettes is the best insurance against recurrence.

**Brucella Spondylitis. Case Report.** Martin Dobelle. *Am. J. Surg.* 60: 130-133, April 1943.

The author reports a case of undulant fever in which serial roentgenograms showed a rapidly progressive destruction of the fourth lumbar vertebra with suspicious involvement of the third. A successful fusion operation was done and a course of brucellin therapy was given, with favorable results.

**Arthritis of the Acromioclavicular Joint.** Albert Oppenheimer. *J. Bone & Joint Surg.* 25: 867-870, October 1943.

Of the many painful conditions about the shoulder joint, arthritis of the acromioclavicular joint has received but little attention in the literature. There is no clinical or physical sign characteristic of this particular form of joint involvement but roentgenograms will show characteristic changes.

Normally the joint is a clear space 1 to 3 mm. wide, with the articular surfaces clean-cut and straight, notched, convex, or concave. The articular capsule and ligaments cast a tubular or spindle-shaped shadow about the joint not rising more than 1 mm. above the joint edges.

Tuberculous arthritis is of rare occurrence. Rheumatoid arthritis is seen, but is also found in other joints. Osteoarthritis is much more common. The findings are enlargement of the capsule, narrowing of the joint space, and eburnation of the joint surfaces. Or there may be marginal overgrowth and roughening of the joint surfaces with widening of the space. The subchondral bone shows an irregular honeycomb appearance.

The author has had great success with roentgen therapy in these cases. He gives 50 r through a 5 × 5 cm. portal every five to seven days for two to eight treatments. The factors used are 140 kv., 20 ma., 0.5 mm. Cu and 1.0 mm. Al at 50 cm. distance.

JOHN B. McANENY, M.D.

**Air Arthrography in the Diagnosis of Internal Derangement of the Knee-Joint.** E. W. Somerville. *Proc. Roy. Soc. Med.* 36: 663-664, October 1943.

Thirty patients suspected of having some internal derangement of the knee joint were examined by air arthrography. In 9 the findings were negative. Roentgen evidence of meniscus injury was confirmed in 18 cases at operation. Air arthrography was unsuccessful in the remaining 3 cases because of effusion that obscured the cartilages.

The technic includes a twenty-four hour skin preparation. From 80 to 120 c.c. of air, filtered through cotton-wool, is injected into the joint space until a positive pressure is produced. A firm bandage is wrapped above the knee to empty the suprapatellar pouch. The knee is held in flexion over a curved cassette and the lateral or mesial joint space to be examined is further widened by adduction or abduction of the tibia. Three tangential views are then made of each cartilage to demonstrate the anterior, middle, and posterior portions. A true postero-anterior projection of the knee joint is also made with the knee in flexion.

Reaction consisting of moderate pain and effusion occurred in 8 patients and lasted for a few days.

Reproductions of roentgenograms accompany this brief report. LESTER M. J. FREEDMAN, M.D.

**Hemangioma of the Synovial Membrane of the Knee Joint Cured by Synovectomy.** Paul H. Harmon. *Arch. Surg.* 47: 359-363, October 1943.

All published cases of hemangioma of the knee joint include the same striking symptoms and signs. Intermittent swelling is usually of many years' duration and is confined to the single joint. It is of insufficient moment to detract from the patient's general health. Examination in the acute phase shows that elevation or compression of the joint leads to disappearance of the swelling. Motion is limited by the swelling. Roentgenograms may reveal no abnormality except enlargement of the soft tissue shadow, or they may show subcortical absorption beneath the articular surfaces, a change similar to that seen in the recurrent hemorrhages of hemophilia. The monarticular distribution and absence of blood changes will rule out this latter condition. The final diagnosis is usually established by arthrotomy. The tendency to profuse hemorrhage can usually be controlled by packing or by constriction of the blood supply to the extremity.

The pathological changes may consist of a diffuse involvement limited to the synovial membrane, or the lesion may be of a cavernous form involving the surrounding muscles and fasciae. The tendency to spread is limited.

Treatment consists of synovectomy. Sclerosing agents are unsuccessful, but in 3 instances cure was effected by roentgen rays and radium (reported by Bennett and Cobey: *Arch. Surg.* 38: 487, 1939). A case in a 9-year-old boy treated successfully by synovectomy is reported in this article. LEWIS G. JACOBS, M.D.

**Synovioma Involving the Knee Joint: Case Report.** Malcolm S. Eveleth and Philip S. Brezina. *Yale J. Biol. & Med.* 16: 27-30, October 1943.

A "diffuse" synovial sarcoma is reported in a 61-year-old white female. The history was of four years' duration and shows the difficulty in making an early diagnosis. The symptoms were: steady boring pain, not relieved by heat or rest; progressive increase in the size of the joint; flexion deformity of the knee with loss of ability to flex and extend the joint. Inguinal metastases were present and a palliative amputation was done to relieve pain. The diagnosis was confirmed by gross and microscopic examinations, which are reported in detail. X-ray therapy to masses in the groin caused some decrease in size, although these tumors do not respond well to irradiation.

X-ray examination of the right knee joint revealed a poorly circumscribed, lobulated soft-tissue tumefaction appearing to infiltrate the muscles. There was extensive destruction of the cortex of the lower third of the shaft, metaphysis, and condyles, with periosteal new bone formation of parallel and perpendicular type. In the femoral condyles small areas of rarefaction alternated with zones of sclerosis. Narrowing of the joint space was demonstrable, with a break in the cortical outline of both condyles.

Lazarus and Marks (*Surgery* 13: 290, 1943) state there are 76 recorded cases of synovioma, of which 48.7 per cent occurred in the knee joint. Synoviomas are



classified as: (1) encapsulated or circumscribed; (2) diffuse. Treatment consists in wide excision for easily accessible, small, encapsulated tumors and amputation for highly malignant growths, inaccessible encapsulated tumors, and local recurrences.

SIDNEY LARSON, M.D.

**Osteochondritis Dissecans of the Astragalus.** Milton C. Cobey. *Mil. Surgeon* 93: 184-186, August 1943.

Three cases of osteochondritis dissecans of the dorsal surface of the astragalus are presented. Although osteochondritis dissecans of the ankle is rarely seen, the author urges a careful x-ray examination of every sprain of this joint, in order that appropriate treatment may be instituted promptly. In each of the cases reported here, a roentgenogram showed a defect in the dorsal articular surface of the astragalus. Surgical excision of the plaque was done in all three instances, with complete recovery; the period of disability was prolonged, however, in two of the patients because in one the condition was not recognized for seven months and in the other early adequate treatment was not carried out.

**Congenital Talonavicular Synostosis. Case Report of a Rare Anomaly.** D. H. O'Donoghue and L. Stanley Sell. *J. Bone & Joint Surg.* 25: 925-927, October 1943.

Talonavicular synostosis is a rare congenital anomaly of the foot and may be accompanied by other abnormalities of bone formation. The authors present the seventh recorded case. The unusual features in this instance are two rather large cuneiform bones in place of the usual three and the bilaterality of the anomalies.

JOHN B. MCANENY, M.D.

## GYNECOLOGY AND OBSTETRICS

**Study of the Uterine Canal by Direct Observation and Uterogram.** W. B. Norment. *Am. J. Surg.* 60: 56-62, April 1943.

Two methods are described for detecting submucosal myomas protruding into the uterine canal and uterine polyps producing bleeding. The first is by direct observation through a foroblique telescope following insertion into the uterus of a rubber tissue bag which is inflated with air or water. By this means a greater part of the uterine canal may be visualized and the endometrium observed in its natural color.

The second method of study is by the uterogram. After dilatation of the cervix and curettage in the usual manner, a small rubber tissue bag (half the length of the depth of the uterine canal), attached to the end of a two-way mushroom catheter, is inserted into the uterus. If the bag is moist, this can be accomplished with ease by a uterine probe. To determine the position of the bag, a small amount of air, usually 6 to 10 c.c., is instilled into it before the patient leaves the operating room. If there is difficulty in instilling the air, the bag is withdrawn and re-inserted. The following day the patient is taken to the x-ray room, the bag is again instilled with air, and anteroposterior, postero-anterior, and lateral roentgenograms are made, covering the entire circumference of the bag. Defects in the contour of the bag thus observed suggest the possible presence of a submucosal myoma or polyp. The defect, if found, is usually fairly definite and with a wide base. Small defects on one contour of the balloon may be due to an

excess amount or wrinkling of the bag in the uterine canal. In the event of their occurrence, the air in the bag should be released and further x-ray studies made to determine if the defect persists. If there is much gas in the intestinal tract, as shown on a flat plate made previous to the insertion of air, it may be difficult to distinguish the outline of the air from the gas in the intestine. In this event an opaque medium may be substituted for the air, a 12.5 per cent sodium iodide or diodrast solution probably being the best. If a definite defect is found on one contour of the bag with this solution, a weaker solution, 3 to 4 per cent of sodium iodide, is injected. If there is a displacement of the weaker dye, it is believed that there is probably a growth protruding into the uterine canal.

Originally a No. 18 catheter was used in place of the mushroom catheter but, in spite of the fact that the vagina was firmly packed with gauze, the bag was frequently expelled into the vaginal vault in the reaction from the anesthetic. With the present technic the bag is attached to the mushroom catheter by a fine silk thread and is inserted with the aid of a uterine probe in the eyelet of the catheter, similar to insertion in the bladder. As the mushroom tip is beyond the internal os, expulsion of the bag is prevented. The dye is instilled in one opening of the two-way catheter and allowed to return through the other until no air is expelled. Following this, one end is clamped and the dye is injected.

This method of uterography has a number of advantages over ordinary salpingography. The folds of the uterine canal are pressed out, the bag can be inserted, the tube clamped, and different angle x-ray studies of the uterine canal can be made which would be impossible with the usual method. There is no leakage of the dye out of the cervical canal or the fallopian tubes. There is constant pressure in the uterine canal when the bag is used so that in x-ray studies from different angles the contour is of the same size and comparison is facilitated. There have been no ill effects following this procedure.

The author believes that by the use of the two methods described, the submucosal myoma or polyp may be detected more easily than by the curet. They will also aid in determining whether a palpable fibroid on the serosal surface is the cause of uterine bleeding or is merely coincidental.

**Uterography. An Aid in the Diagnosis of Gynecological Pelvic Disorders.** Ben H. Brunkow. *Am. J. Surg.* 61: 394-399, September 1943.

The author describes his technic for uterography and discusses its advantages in the diagnosis of gynecological disorders, based on a review of 100 unselected cases.

A careful history of the patient should be taken and a physical examination should be made before uterography is begun. With the patient in lithotomy position, the cervix is exposed and grasped with tenacula and the cervical canal is explored with a small sound. The tip of a uterine cannula is inserted into the cervix, pushed firmly up to the rubber stopper, and held in place with tenacula. About 2 c.c. of heavy brominal are injected at a time and a roentgenogram is taken immediately. The usual number of x-ray exposures is three or four, i.e., three anteroposterior and one lateral. Delayed emptying of the material from the uterus or the fallopian tubes may be checked at twelve to twenty-four hours after the injection. Normally



emptying occurs in twelve hours. The brominal used in the cases studied was well absorbed in twenty-four hours.

Uterography is particularly useful in the diagnosis of endocervicitis, intra-uterine tumors, carcinoma, and the chronic forms of adnexal disease in which the pathological process is not readily palpable. It is strongly contraindicated during pregnancy.

**Fallopian Tube Visualization.** Jason H. Robberson. *Texas State J. Med.* 39: 340-346, October 1943.

Uterosalphingography is a simple and safe procedure providing the following contraindications are observed: pelvic inflammatory disease; advanced cardiac lesions; recent uterine bleeding, which may be secondary to neoplasm; the immediate premenstrual, menstrual and postmenstrual periods; pregnancy; any severe constitutional ailment. This method of examination is a distinct aid in the determination of abnormalities of the cervical canal, uterine cavity, and fallopian tubes. Particular emphasis is placed on its value in demonstrating tubal patency. The question of sterility is discussed in some detail.

Although the author admits that lipiodol produces a clearer and more detailed roentgen picture, he prefers the use of skiodan-acacia because of its rapid excretion. The usual amount of the solution required is 5 to 8 c.c. A second or third roentgenogram is made several minutes following the initial exposure. Because of the rapid absorption of the skiodan mixture, a 24-hour roentgenogram is useless. The author describes his technic.

Reproductions of roentgenograms, made with both lipiodol and the skiodan mixture, are furnished, showing a normal internal genital system, a bicornate uterus, a chronic hydrosalpinx, surgically sealed fallopian tubes, and a uterine fibroid.

LESTER M. J. FREEDMAN, M.D.

**Parasitic Ovarian Cysts.** Herman I. Kantor. *Am. J. Obst. & Gynec.* 46: 412-417, September 1943.

The development of parasitic tumors may be divided arbitrarily into four stages, depending on the degree of diminution of the primary blood supply: (1) reduction in the original vascular supply, due usually to a slow torsion of the mass on its pedicle; (2) formation of adhesions between the mass and adjacent tissues or the omentum; (3) additional torsion and a further decrease in the primary blood supply followed by secondary vascularization through the adhesions; (4) further torsion to the point of complete amputation of the pedicle. With the fourth stage the tumor takes on a completely parasitic existence and the pedicle tends to become atrophied and fibrotic.

Among the ovarian parasitic tumors, the type most frequently seen is the dermoid. This is as would be expected, since the ovarian dermoid often is subject to torsion. Serous cysts, solid ovarian tumors, and relatively normal adnexa have been reported.

These parasitic cysts are most often associated with the omentum, in which they tend to become embedded. They have been found, however, attached to the uterus, the broad ligament, the bowel, and the bladder. The parietal peritoneum is occasionally involved.

An accurate preoperative diagnosis of parasitic cyst of the ovary has not been made. Pain has been the predominant symptom in almost all of the recorded cases.

In the case presented here the x-ray films revealed

several clusters of calcification within the pelvis. One had the typical appearance of a calcified fibroid and another was thought possibly to be an additional fibroid. No abnormality in either the urinary tract or bladder was found by intravenous pyelography, but the calcified masses caused extrinsic pressure on the bladder.

On exploratory laparotomy, the right ovary was found to be converted into a multilocular dermoid cyst containing three separate portions. It was attached laterally by the right infundibulopelvic ligament, about which the amputated right tube was twisted. It was attached also to the peritoneum over the dome of the bladder by a pedicle. Both of these pedicles were twisted. A single smaller dermoid cyst, probably part of the right ovary, was found embedded extraperitoneally in the right lateral pelvic wall. In addition, another cyst posterior to the uterus was found, which was attached completely to the omentum by a pedicle. This was twisted 2 1/2 times on itself, but a new band from the omentum to the lateral aspect of this cyst was not twisted. The patient made an uneventful recovery after removal of the cysts.

The torsion of the omental cyst in this case represented a beginning decrease of the secondary vascular supply. The new band of tissue suggested the beginning of the tertiary stage, while the calcified and necrotic dermoid found in the lateral pelvic wall probably indicated the end stage of development, a quiescent, completely parasitic, degenerated tumor. The finding of ovarian tissue in the omental cyst may explain the etiology of some dermoid cysts thought to be primary in the omentum.

STEPHEN N. TAGER, M.D.

## THE GENITO-URINARY TRACT

**Estimation of Renal Function Based on Specific Gravity Changes Following Intravenous Urography.** George O. Baumrucker. *J. Urol.* 50: 290-300, September 1943.

Baumrucker states that the excretion of diodrast and the related iodide preparations used in intravenous urography closely parallels phthalein excretion, and that these substances are of value for kidney function tests. The advantage of these compounds is that they can be used on patients with bloody urine. It has also been found that there is a close correlation between the excellence of the pyelogram and the increase in the specific gravity of the urine following diodrast injection. Good contrast urograms are secured in those patients in whom the specific gravity of the urine rises to at least 1.040 during the test. This rise in specific gravity is due undoubtedly to a concentration of the excreted urine by the excreted diodrast. Taken together with the volume of the urine excreted in any given time, it furnishes a basis for calculating the amount of contrast material excreted. The following formula is used:

$$\text{Volume of dye} = \frac{(\text{vol. of mix.}) \times (\text{increase in specific gravity})}{(\text{sp. gr. of dye}) - (\text{sp. gr. of urine})}$$

in which the *volume of dye* is the amount of dye excreted, *vol. of mix.* is the amount of urine excreted with dye in an arbitrary time period (which the author advises should be 15 minutes to fit with the 15-minute phthalein test), and *increase in specific gravity* is the specific gravity of the urine during the test minus the specific gravity of the urine immediately before the test.

The author recommends that films be made in the Trendelenburg position at five and fifteen minutes after injection of the dye, and another in the erect position immediately thereafter. He finds that there is thus better filling of the pelvis and ureters. The patient is catheterized before injection of the dye and immediately after the fifteen-minute film, if there is any residual urine. Otherwise he voids at these times. The specific gravity of the two specimens and the volume of the second are determined. The specific gravity of 35 per cent diodrast is 1.193; of 50 per cent neoipax 1.335; of 75 per cent neoipax 1.495.

JOHN O. LAFFERTY, M.D.

**Management of Hydronephrosis Due to Ureteropelvic Obstruction: Preliminary Report.** Roy B. Henline and Joseph H. Menning. *J. Urol.* 50: 1-24, July 1943.

Because of the high incidence of nephrectomy and the poor results obtained by plastic repair for hydronephrosis due to ureteropelvic obstruction, the authors discuss three principles in the successful management of these cases.

- (1) The true etiology of the condition must be discovered. In the majority of the cases, this is a stenosis at the ureteropelvic junction. The much blamed aberrant renal vessel is usually not the cause or is only a secondary finding at operation.
- (2) The surgical procedure must restore a well draining pelvio-ureteral outlet.
- (3) Satisfactory plastic repair requires prolonged nephrostomy drainage and splinting of the area of repair.

In this preliminary report 18 operations on 14 patients are presented, the longest follow-up period being seven months. Final results must necessarily wait for years.

Often the only symptoms of this condition are vague gastro-intestinal complaints. Pain is the outstanding feature, and its severity is proportional to the speed with which the hydronephrosis develops. The urine is negative until infection is superimposed. Urinary findings and symptoms will then be obtained. Diagnosis is based on the retrograde pyelogram. While dilatation of the pelvis is considered a helpful finding, delay in emptying time of the pelvis is stressed. Little importance is placed on reduced function of the affected kidney, as the function often improves after prolonged drainage.

The causes for obstruction are: congenital or acquired stenosis at the ureteropelvic junction, hypertrophy of the ring muscle at the ureteropelvic junction, high insertion of the ureter in the pelvis, fibrous bands with kinks of the ureter, accessory renal vessels, congenital ureteral valves, and combinations of the above. In 15 of the 18 kidneys examined ureteropelvic stenosis was found, while only one case was considered to be due solely to an accessory renal vessel. In some of the cases the caliber of the ureter could not be gauged from its external appearance. In such cases, the pelvis of the kidney should be distended with saline injected through a fine needle, and the emptying time observed. With delayed emptying, the ureter, when opened, will often show stenosis not suspected before incision.

For repair a modification of the Y-plasty procedure described by Schwyzer is used. Through a nephrostomy a 24 F mushroom catheter is placed in the renal pelvis and a 10-12 F soft rubber catheter is run down

the ureter past the site of the plastic repair. In general, these catheters are left in place until the roentgenograms, taken with dye run into the renal pelvis through the mushroom catheter, show no leakage from the site of the anastomosis. This is usually four to six weeks.

Primary emphasis is placed on this prolonged drainage and splinting of the operated ureter until plastic repair is complete, to prevent secondary scarring and contraction.

Reports and roentgenograms of the 18 cases, with illustrations of the operative technic, are presented.

J. FRANCIS MAHONEY, M.D.

**Renal Ectopia: Report of Two Cases with a New Method of X-Raying Pelvic Ectopia.** Nicholas S. Scarcello. *J. Urol.* 50: 25-28, July 1943.

The author reports a case of bilateral renal ectopia, the 23d such case recorded in the literature. The advisability of a complete urological study in cases presenting lower abdominal masses is pointed out, so that exploratory operation may be avoided, since in this condition operative treatment is not necessary.

In the case reported, the intravenous urogram was unsatisfactory, but a retrograde pyelogram disclosed a bilateral ectopia.

A case of unilateral ectopia is also described in connection with which it is suggested that films be made with the patient in the prone position and the tube angled 45 degrees. In this way, the shadow of the dye-filled pelvis is projected away from the sacrum so that visualization is improved.

ELLIS C. OSGOOD, M.D.

**Report of a Case of Wilms' Tumor in an Adult.** Martin J. Loeb. *J. Urol.* 50: 268-273, September 1943.

The origin of renal tumors, particularly of the embryonal type, is still under discussion, with most observers no longer subscribing to the original conception advanced by Wilms that the tumor bearing his name arises from the inclusion of various embryonal tissues. With frequent reference to the literature, the author summarizes the evidence in support of the premise that these tumors are derived from the renal blastema. This is mesenchymatous embryonal tissue, which may differentiate into all the elements composing the kidney, *viz.*, epithelial, glandular, vascular, and connective tissue, thus allowing for considerable variation in the histopathologic structure of the tumors. The author states, however, that these are usually adenomyosarcomata and all may be classified as embryomata.

Typical adenomyosarcomata, as originally described by Wilms, occur rarely in the adult, the present case bringing the total number reported up to 30. After reviewing the work of L. W. Smith on renal neoplasms, however, the author expresses the opinion that true sarcomata represent variants of Wilms' tumors and as such should be included. Were this done, the number of cases in adults would be greatly increased.

The case recorded here is that of a 49-year-old housewife who had symptoms referable to the right flank for approximately one year prior to admission, with acute pain, urgency, frequency, and hematuria of one week's duration. Cystoscopy showed bloody urine in the bladder. On ureteral catheterization bloody urine was obtained from the right kidney with no return of indigo carmine from that side. Bilateral pyelograms revealed nothing abnormal on the left but showed on the right

side a gross enlargement of the kidney in the region of the upper pole, with elongation and distortion of the superior calices. A communicating area was also filled with the dye, leading to a roentgen diagnosis of cyst of the upper pole of the right kidney. The preoperative clinical diagnosis was carcinoma of the kidney.

A right nephrectomy was performed and a postoperative diagnosis of Wilms' tumor was made. Photographs of the gross specimen and photomicrographs of the pathologic sections are included.

A course of postoperative roentgen therapy was given and the patient was well twenty months later.

AGRIPPA G. ROBERT, M.D.

**Primary Carcinoma of the Ureter.** Samuel A. Jaffe and Anthony J. Mendillo. *Am. J. Surg.* 62: 126-133, October 1943.

Primary carcinoma of the ureter is a comparatively rare disease, though, with improvements in urologic technic, it is now being recognized more frequently. Two-thirds of all the reported cases have been published in the past ten years.

Ureteral neoplasms may be papillary or non-papillary. The tumor may involve one or several parts of the ureter, may be small or extensive, and may or may not encircle the lumen. Spread tends to occur to surrounding tissues, to regional lymph nodes, and by the blood stream to other parts of the body, particularly the liver and lungs. In about 75 per cent of the reported cases, the primary growth occurred in the lower third of the ureter. In many cases it has been seen cystoscopically, protruding into the bladder through the ureteral orifice.

Hematuria is the most frequent and earliest symptom, appearing in about 75 per cent of the reported cases. Pain is next in frequency. It may be one or any combination of the following types: (1) ureteral colicky pain, due to ureteral obstruction or the passing of blood clots down the ureter; (2) dull aching pain in the kidney region and in the flank, due to ureteral or pelvic distention; (3) referred pain, due to involvement of the neighboring tissues. The neoplasm itself is seldom palpable, but the enlarged hydronephrotic kidney secondary to the ureteral obstruction may be felt as a mass in the loin.

Urinalysis, cystoscopy, and urography are of utmost importance in the diagnosis of ureteral cancer. Red blood cells are undoubtedly present in the urine at some time; pus is generally found; cancer cells or even fragments of the tumor may occasionally be seen. Cystoscopic examination may show blood spurting from the affected ureter; if obstruction from the growth is complete, no urine appears from the ureteral orifice.

A film of the abdomen often shows an enlarged kidney shadow due to the associated hydronephrosis. Excretory urograms are of limited value in demonstrating either a filling defect or the stricture in the ureter. Retrograde pyelo-ureterography is the procedure of choice to reveal the actual lesion and its position. A catheter must be passed, or at least its tip engaged in the ureteral orifice, so that the ureter may be filled sufficiently to show the defect. It is important to note whether the filling defect is constant. For this purpose, serial pyelograms are advised. The filling defect may take several forms: (1) a ring-like obstruction; (2) an ovoid defect, large or small; (3) a moth-eaten appearance, due to extensive involvement by a papillary type of neoplasm; (4) multiple defects, due to many implantations.

A bleeding ureteral neoplasm may be so small that it will not cause obstruction, will not show a filling defect, will not produce hydronephrosis, and will not appear as a palpable mass upon surgical exposure. If a nephrectomy has been performed and the kidney does not explain the source of bleeding, or if there is persistent hematuria after the nephrectomy, prompt ureterectomy should be carried out. It is also of utmost importance that in all cases of hydronephrosis, especially in patients over fifty years of age, the causative factor be definitely ascertained.

In the treatment of tumors of the ureter, the best surgical procedure at present is a total nephro-ureterectomy with removal of a cuff of the bladder and of the perirenal and peri-ureteral fat. Preoperative and postoperative irradiation are worth while. Postoperative irradiation helps to prevent local and bladder recurrences and to relieve the pain of extension and metastases. In the past, the prognosis in ureteral cancer has been poor. It is now vastly improved because of earlier diagnosis, earlier and more adequate surgery, and proper irradiation.

Two cases of primary carcinoma of the ureter are presented, bringing the total number of reported cases to 175.

**Solution of Vesical Phosphatic Calculi.** Daniel J. Abramson. *J. Urol.* 50: 197-201, August 1943.

Urinary lithiasis long has been one of the major problems of urologists. Solution of calculi by medical means has been desired. Crowell and also Albright, Sulkowitch, and Chute demonstrated the solution of cystine stones by alkalization of the urine. Higgins had some success with large doses of vitamin A and an acid or alkaline ash diet. Suby and Albright have reported six cases of phosphatic calculi dissolved with their solution "G" (citric acid, magnesium oxide, sodium carbonate).

The author reports a case in which a large phosphatic bladder calculus was dissolved by solution "G" when surgical intervention might have proved fatal. His patient was a 64-year-old white male on whom cystotomy and two transurethral resections had been performed in 1941. In April 1942, a large bladder calculus, 3 X 2 cm., was discovered. Since the patient was a poor surgical risk, treatment consisted of attempts to acidify the urine. This was unsuccessful. By December 1942 the calculus had increased in size. Bladder irrigations with citric acid solution (solution "G") were carried out intermittently from Dec. 5, 1942, to Jan. 1, 1943. By January 6 the stone had disappeared and voiding could be performed satisfactorily.

There was no chemical analysis of the calculus, but the author states that it was undoubtedly a phosphatic one, since it occurred in an alkaline urine caused by *B. coli*, in which phosphatic crystals were found. It was due to stasis resulting from prostatic hypertrophy and infection by *B. coli*, a urea-splitting organism.

The advantages of the irrigation method of treatment with solution "G" are as follows. It is associated with very little discomfort; is suitable for the aged; removes dangers of operative manipulations and complications; avoids irritation of the bladder mucosa, thought to be due to the action of the magnesium ion. It is thought that it not only dissolves the calculus but also loosens organic matrix.

STUART P. BARDEN, M.D.

**Adenoma of the Kidney with Associated Lesions: Report of Three Cases.** Henry Bugbee. *J. Urol.* 50: 389-398, October 1943.

Renal adenomas are usually small, single or multiple benign tumors of gray or yellow color. They are located in most instances beneath the renal capsule and are clinically silent, except in the rare event that one reaches such dimensions as to offer the serious problem of differentiation from malignant tumor.

Three histological patterns are recognized. In one, the cells are arranged in groups without distinct lumina. In another type the ducts may be dilated and show hyperplasia or actual papillary formations. The third variety resembles adrenal rest tissue and is made up of cuboidal or cylindrical cells which may or may not contain fat. There is no sharp dividing line between adenoma and normal epithelium on the one hand and carcinoma on the other.

Three case histories are reviewed. In the first case, that of a 43-year-old man, a hydronephrotic, sclerotic kidney was removed. It contained a small subcapsular adenoma characterized by cuboidal cells forming acini. In the second patient, a woman aged 57 years, the excised kidney was a pyonephrotic sac containing two calculi. An adenoma measuring  $3.5 \times 2.5$  cm. was present in the upper pole, showing histologically closely packed tubules lined by cuboidal fat-containing cells. The third patient, a 54-year-old man, was operated upon for renal tuberculosis. The kidney revealed, in addition to the tuberculous abscess in the lower pole, a large adenoma in the upper pole, measuring 5 cm. in diameter. This was well encapsulated and made up of cuboidal and columnar cells in papillary arrangement. The remaining parenchyma was markedly sclerotic.

The author believes that these cases lend support to the theory that adenomas arise most frequently in kidneys altered by vascular sclerosis and are the result of reactive proliferation of tubules. He emphasizes the fact that large adenomas can rarely, if ever, be differentiated from carcinoma prior to surgery.

JOSEPH SELMAN, M.D.

## VENOGRAPHY

**Venography. I. Its Use in the Differential Diagnosis of the Peripheral Venous Circulation. II. A Simplified Technic.** Jerome Mark. *Ann. Surg.* 118: 469-477, September 1943.

J. C. dos Santos' method for the roentgenologic study of the veins of the lower leg is described. The heel is elevated on a 6-cm. block and rests on its mesial surface. Under local anesthesia a 2-cm. incision is made 1 cm. behind the external malleolus. The lesser saphenous is isolated, the distal portion tied, and a small cannula inserted into the proximal portion. Twenty cubic centimeters of a 35 per cent diodrast solution are injected at a uniform rate, taking about 60 seconds. The roentgenogram is taken during the injection of the last few cubic centimeters. It is possible to picture the deep venous circulation of the calf and a good portion of the femoral vein on a  $14 \times 17$  in. film.

The author has found it possible, in most cases, to modify this technic by direct venopuncture. With a tourniquet around the ankle, a No. 21-22 gauge needle is inserted into the most prominent vein on the anterolateral surface of the ankle. The tourniquet is then released, and the remainder of the procedure is completed as described. Better visualization of the

deep venous tree is secured by an exaggerated Trendelenburg position. The application of a tourniquet below the groin prevents loss of the dye before the picture is taken and causes more complete filling of the deep system.

Venography has been employed in many obscure cases of chronic leg swelling and leg pain in which the status of the venous and lymphatic circulation could not be readily determined by the usual chemical tests. A number of cases are presented. Of special interest is a case of Buerger's disease in which marked changes in the deep venous tree were demonstrable.

## FOREIGN BODIES

**Foreign Body Localization and Extraction. Description of a Method More Accurate Than That Used by the Army.** Lewis Gregory Cole. *Am. J. Surg.* 60: 3-12, April 1943.

A two-point method for the localization of foreign bodies is described. One mark is made on the upper surface and the other on the under surface of the part to be examined, each in line with the foreign body as observed fluoroscopically with the tube beneath the table. The mark on the upper surface is recorded in exactly the same manner as in the one-point method now in use in the U. S. Army. To determine the location of the second mark a ring pointer may be placed beneath the part and moved into such a position that the shadow cast by it on the fluoroscopic screen perfectly encircles the image of the foreign body. A line drawn through the two points transects the foreign body. An x-ray caliper has been designed and constructed to facilitate making both of these marks at one time. The accuracy with which the roentgenologist does this is recorded on a small roentgenogram made either on film or on paper.

A companion surgical caliper is so constructed that the part can be repositioned by the surgeon exactly as it was at the time the localization was done by the roentgenologist. To do this the distal end of the lower arm of the surgical caliper is fixed on the under mark and the part so positioned that the distal end of the upper arm rests exactly on the upper mark. The foreign body must therefore lie in a direct line between the end of the upper arm and the end of the lower arm of the caliper. In the upper arm of this caliper there is a knitting-needle-like pointer that acts as a guide to direct the surgeon toward the foreign body. There is also a stop on the pointer which indicates the exact depth of the foreign body beneath the surface.

In the author's opinion the two-point method is much more accurate than the one-point method adopted by the Army, with the additional advantages of adaptability to any available apparatus, greater convenience, and low cost. Both fluoroscopic and roentgenologic examinations can be made. Furthermore, the x-ray unit and localizing equipment can be taken to the patient, which is impossible with the one-point method.

**An Adaptor for Fluoroscopic Depth Localization.** Leo Mackta. *Mil. Surgeon* 93: 372-375, October 1943.

A fluoroscopic depth localizer for foreign bodies, adaptable to most commercial fluoroscopes without any depends upon the measured movement of a lead wire in a cassette-like box of thin plywood,  $12 \times 16 \times 3/4$  in. The patient is placed against the box, on the fluoroscopic table, and the depth determined is meas-

ured from the part of the patient in contact with the box. The shadow of the foreign body is made to move from one end of the screen to the other by moving the tube screen set in its guides. The lead wire is shifted by a sliding arm projecting from the box. Along this arm is a second (dummy) slide which is used for the initial or zero setting. The method of operating the localizer and the details of construction are given.

### TECHNIC

**Optimum Kilovoltage Technique in Military Roentgenography.** Arthur W. Fuchs. *Am. J. Roentgenol.* 50: 358-365, September 1943.

For a given thickness of a particular body part, the wave length of the roentgen rays employed to penetrate the tissues must be adequate or, in other words, optimum. The milliamperage and time control the number of roentgen rays or intensity of radiation, and proper adjustment of these factors will produce ade-

quate exposure of the roentgen film. When the roentgen-ray wave length is optimum, a lesser amount of milliamperage-seconds is usually needed for the exposure than that habitually employed for the same purpose with lower kilovoltages. When optimum kilovoltages are used, the exposure latitude is sufficiently great to permit either halving or doubling the milliamperage-second value to obtain the desired density for each thickness classification of patient.

A consolidated technic chart, including standard roentgenographic projections, is furnished in the text. In using the chart any density differences should always be compensated for by milliamperage-seconds and not by kilovoltages, because the latter have been proved qualitatively optimum for the projections listed.

The author has found that this technic greatly facilitates the training of Army roentgen-ray technicians, and it was for this purpose that the exposure system described was developed.

CLARENCE E. WEAVER, M.D.

### RADIOTHERAPY

#### NEOPLASMS

**Pulmonary Metastasis and Pneumonitis Following Radiation Therapy for Cancer of the Breast.** Eugene P. Pendergrass and George White. *Am. J. Roentgenol.* 50: 491-498, October 1943.

A study of 54 cases of cancer of the breast with pulmonary metastases is reported. The authors were interested in determining whether irradiation prior to the metastasis will influence the type of shadow that the subsequent metastatic lesions will produce and also to determine whether infiltrative metastases of the lung from cancer of the breast can be differentiated from radiation pneumonitis.

The metastatic lesions were classified according to their essential types as nodular, infiltrative, and pleural (with or without effusion). The analysis of this series of cases seems to indicate that increasing amounts of premetastatic irradiation to the lung fields tend to be followed by the infiltrative type of metastases, when these do develop, while the nodular type usually occurs where little or no radiation has been directed to the lung field. The pleural type of metastasis occurred equally after all degrees of irradiation. The diagnosis of nodular and pleural metastases is not difficult, but the infiltrative type may be confused with pneumonitis following irradiation.

In addition to the changes described by others as occurring in radiation pneumonitis, the authors observed bleb formation on the affected side in 3 cases. The blebs appeared to be secondary to the extensive lung changes in patients who had lived for years following treatment. In one patient a pneumothorax developed after a possible rupture of one of the blebs, and no unusual changes in either the parietal or visceral pleura could be seen. There were no pleural adhesions and the lung collapsed readily from the thoracic wall. The term "radiation pneumonitis" seems to be a more accurate description for the condition than pleuropneumonitis, since involvement of the pleura may not be present.

The authors were unable to find a group of diagnostic criteria which would enable one to differentiate between infiltrative metastases and pneumonitis. All the changes

that occur following irradiation may also appear as a result of infiltrative metastasis, with the possible exception of bleb formation.

L. W. PAUL, M.D.

**Frequency, Clinical Course and Treatment of Metastases from Cancer of the Breast.** Jacob R. Freid and Henry Goldberg. *Am. J. Roentgenol.* 50: 499-511, October 1943.

The data presented in this report are based on patients with cancer of the breast who died while on the radiotherapeutic and surgical services of the Montefiore Hospital for Chronic Disease, New York City. The material is divided according to the anatomical sites of involvement as follows: skin; regional lymph nodes; skeleton; lungs, pleura, and mediastinal lymph nodes; abdominal viscera; central nervous system.

The treatment of diffuse skin lesions is difficult and frequently fruitless. Isolated nodules or groups of nodules in small areas may be treated either by irradiation or surgery, but radiotherapy is preferable because it is less likely to be followed by further recurrences.

Metastatic involvement of the nodes in the axilla is difficult to control by irradiation, and palliation is about all that can be hoped for. Supraclavicular node metastases are usually a late manifestation, not amenable to irradiation. When supraclavicular nodes are seen earlier in the disease, with no evidence of extension elsewhere, intensive radiation therapy is indicated over a field considerably larger than the area of involvement.

In a review of 81 cases with skeletal metastases, it was found that in most of them the lesions were multiple, and in the majority there were associated metastases in other body systems. Pathological fractures of one or more of the long or flat bones were encountered in 26 per cent. Such fractures may heal if treated by radiation. The mode of treatment is determined by the extent of the lesions and the stage of the disease. When the foci are numerous, treatment is limited to the sites causing symptoms or to areas where fracture seems imminent. When the foci are slowly growing, and new involvements are few or absent, intensive therapy is indicated in order to achieve a more lasting control.

Concerning the involvement of the lungs, pleura, and mediastinal nodes, postmortem studies indicate that this is almost a constant feature. When the metastatic lesions are multiple, they are likely to be resistant to roentgen therapy and little is accomplished by treatment. The single conglomerate infiltration may be kept under control by intensive treatment for periods of time. Pleural effusion may disappear or be greatly improved.

Metastases in the viscera and in the central nervous system were found more frequently than previous reports would indicate. The response of intra-abdominal metastases to irradiation is poor. The same is true of central nervous lesions.

To those interested in this subject, it is recommended that the article be read in the original, since it contains much statistical material which cannot be satisfactorily abstracted.

L. W. PAUL, M.D.

**Superficial Noninvasive Intraepithelial Tumors of the Cervix.** Richard van Dyck Knight. *Am. J. Obst. & Gynec.* 46: 333-349, September 1943.

From January 1927 through April 1943, 406 primary squamous-cell epitheliomata were observed on the gynecologic service of the Sloane Hospital for Women (New York), of which 17 were early, superficial lesions. In 10 of these cases the diagnosis was made from the examination of curettings from grossly normal appearing cervixes in women with fibromyomata or chronic inflammatory disease of the adnexa. In only 2 cases were minute gross lesions of the cervix noted clinically and both were interpreted as papillary erosions. In 2 instances the disease had its origin in cervical polyps. The 17 case histories are given briefly.

The average age of the patients in this series was 44.1 years. Symptoms covered a span of three months to two and one-half years, the average duration being 14.2 months. Eleven patients had irregular intermenstrual bleeding. In the remaining 6 the complaints included profuse menstrual bleeding, abdominal mass, and dysmenorrhea. The presence of a carcinoma was completely unsuspected in 11 cases. In addition to epithelioma, 2 patients had polyps and 9 had fibroids, either of which is capable of producing abnormal vaginal bleeding.

All patients received radium in doses varying from 2,400 to 7,000 mg. hr., followed by deep x-ray therapy. One died in three years, of massive extension throughout the pelvis, and one after nine years, of intestinal obstruction. The other patients were alive at the time of the report. Although many of the cases are rather recent, it appears from the follow-up of the earlier cases that these superficial epitheliomas develop slowly and are relatively benign, as compared with the more obvious larger lesions involving the portio vaginalis. The site of all of these lesions was just at or within the internal os. The presence of squamous epithelium in cervical tissue is not uncommon in chronic cervicitis and polyps of long standing.

Some of the theories which have been advanced to explain the presence of squamous epithelium in cervical glands are discussed. Many authors have considered squamous metaplasia as a stage in the process of healing of cervical erosions. Only a small percentage of cervical erosions, however, reveal metaplasia. Another possibility is the direct transformation of columnar epithelium to squamous epithelium. This process has been noted in advanced chronic inflammatory processes elsewhere in the body.

Among 459 polyps from the Sloane gynecological service, 53 showed evidence of metaplasia, but of these, only 2 were malignant. Since 1927, the diagnosis of squamous metaplasia of cervical tissue has been made 232 times. In none of these lesions, except for the cases here reported, was there any evidence of carcinoma. Thirteen of these 17 were in areas of squamous metaplasia.

In none of the cases reported in this paper was any deep invasion found. Only one of the patients, as mentioned above, died of extension of the disease.

As far as prevention and therapy are concerned, there is no doubt that when removal of a uterus is indicated, complete hysterectomy, either by the vaginal route or from above, is the operation of choice, especially in the presence of a diseased cervix. When the diagnosis is made from biopsies, polyps, curettings or trachelorrhaphy tissue, the conventional use of radium and deep x-ray therapy would seem to be the method of choice.

Superficial non-invasive epitheliomata of the type described show occasionally a superficial resemblance to Bowen's disease. Both lesions present a disorderly cellular pattern, but this group of cases does not show the characteristic nuclear clumping and numerous *corps rondes* found in Bowen's disease. These lesions, over a period of time, show invasiveness, as evidenced by violation of the basement membrane. In Bowen's disease this has not been described.

STEPHEN N. TAGER, M.D.

**X-Ray Treatment of Bone Tumors.** Charles L. Martin. *Texas State J. Med.* 39: 285-288, September 1943.

Prolonged palliation and a limited number of cures may be expected from roentgen therapy in carefully selected cases of bone tumor.

Most of the *benign tumors* are radioresistant, but giant-cell tumors, xanthomas, hemangiomas, and eosinophilic granulomas often respond fairly well to irradiation. X-ray therapy is particularly useful where these lesions are deep-seated, as in the spine, pelvis, and upper ends of the femur, where resection is often difficult and may interfere with good function.

In *metastatic bone lesions* relief of pain may frequently be obtained by roentgen therapy. Metastases from malignant melanoma and prostatic carcinoma are usually radioresistant. Those from cancer of the breast, on the other hand, are particularly radiosensitive. Direct irradiation of bone metastases from mammary carcinoma combined with x-ray castration will produce palliative results in a high percentage of cases.

Although no cures of bone- or cartilage-forming *sarcoma* by use of irradiation are recorded, most authorities believe this method useful to relieve pain and as a preoperative procedure. In a recent report concerning a study of 400 cases in the Bone Tumor Registry, Ferguson (*J. Bone & Joint Surg.* 22: 92, January 1940) observes that the number of five-year survivals was greater in that group where amputation was performed four to six months rather than one or two months after the onset of the disease. It is of interest that many patients in the first group received preoperative irradiation. The primary bone tumors most responsive to roentgen therapy are myeloma, reticulo-endothelial sarcoma, and Ewing's sarcoma. In Ewing's tumor, the best results are obtained by preoperative therapy followed by amputation in several weeks.

Four case histories—one of solitary plasma-cell

myeloma, two of Ewing's sarcoma, and one of reticulo-endothelial sarcoma—are presented, with roentgenographic reproductions.

LESTER M. J. FREEDMAN, M.D.

**Osteogenic Sarcoma: I. A Modified Nomenclature and a Review of 118 Five Year Cures.** Ian MacDonald and John W. Budd. *Surg., Gynec. & Obst.* 77: 413-421, October 1943.

This article is based on an analysis of the five-year cures of "osteogenic sarcoma" among the cases registered by the Registry of Bone Sarcoma of the American College of Surgeons. In 1941 there were 1,022 registered cases of osteogenic sarcoma, of which 654 had been treated five years or more prior to 1941. Of this group only 97 (14.8 per cent) were accepted as five-year cures. In the material were found, also, 115 cases of chondrosarcoma with 21 five-year cures. The histories, roentgenograms, and microscopic slides of the cured group were studied, and 47 fatal cases were similarly reviewed.

Of the cured cases 31 per cent were characterized by a spindle-cell morphology with a fibroblastic type of stroma, 46 per cent belonged to the chondroma series, and only 12 per cent were true bone-producing sarcomas. Four cases showed sufficient differentiation to justify a compound name, and 6 cases were regarded as not properly belonging in this series.

For the bone-producing tumors the name "osteosarcoma," a term formerly employed by Mallory, Ewing, and others, is recommended. It is further recommended that the classification of the Bone Sarcoma Registry be modified to include under the Osteogenic Series the following: (a) osteosarcoma, (b) chondrosarcoma, (c) fibrosarcoma, and that the term "osteogenic sarcoma" be used as a generic designation for the triad of connective-tissue sarcomas primary in bone.

The analysis of cured and uncured cases indicated that true osteosarcoma is almost uniformly fatal, while fibrosarcoma is distinctly less malignant. Chondrosarcoma seemed to occupy a median position. Encapsulation of osteogenic sarcoma is a favorable prognostic element, while the amount of matrix was not proved to be of significance in this respect.

Natural selection determined curability to a greater degree than did early treatment, for the delay in radical treatment was greater in the cured than in the uncured neoplasms that were studied. Biopsies were performed with more frequency in the cured than in the fatal cases. The value of irradiation as a complementary curative agent in osteogenic sarcoma could not be demonstrated in the data that were studied, but the authors do not deny the importance of radiotherapy as a palliative measure in many cases.

JOHN O. LAFFERTY, M.D.

**Hemangioma of Vertebra with Compression of Cord: Report of a Case Cured with Radiation Fourteen Years Ago.** L. Minor Blackford. *J.A.M.A.* 123: 144-146, Sept. 18, 1943.

A review of the literature disclosed reports on 65 cases of hemangioma of the vertebrae associated with compression of the spinal cord. In 13 of 14 cases irradiated, excellent results were obtained. The author reports an additional case in which irradiation caused regression of a vascular tumor presenting posteriorly over the right half of the eleventh thoracic vertebra, with complete disappearance of all signs of spinal cord compression. Fourteen years after treatment the

patient was normal clinically. Roentgenograms of the spine made prior to irradiation failed to demonstrate the characteristic striated appearance of hemangioma in bone or any evidence of osseous destruction.

DEPARTMENT OF ROENTGENOLOGY  
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**Consideration of the Response of Bladder Tumors to External Radiation.** Charles C. Herger and Hans R. Sauer. *J. Urol.* 50: 310-321, September 1943.

The response of bladder tumors to external radiation depends on a variety of factors, including the radiosensitivity of the tumor, the technic of irradiation, histology, size and extension of the tumor, kind and degree of infection, kidney function, and the general condition of the patient. Papillary carcinomas of the bladder are an exception to the general rule that the response of highly differentiated tumors to irradiation is poor.

Tumors are classified, according to Warren's suggestion, as radiosensitive tumors, responding favorably to less than 2,500 r; radioresponsive tumors, requiring between 2,501 and 5,000 r; radioresistant tumors, requiring more than 5,000 r to obtain a favorable response.

The authors treated 160 patients with bladder carcinoma in a four-year period beginning Jan. 1, 1938, giving external irradiation before any other kind of therapy was employed. Of these, 15.6 per cent had papillary carcinoma, 56.9 per cent papillary infiltrating carcinoma, and 27.5 per cent solid infiltrating carcinoma. More than half of the papillary growths were multiple, while this was true of only 10 per cent of the solid infiltrating tumors. Irradiation was given (1) in patients with multiple papillary growths of low-grade malignancy; (2) in patients with very large single papillary tumors or large solid infiltrating carcinomas which were not considered suitable for surgical attack at the time of admission; (3) to control hematuria due to bleeding from tumors in which electrocoagulation failed. Small single papillary carcinomas were treated with electrocoagulation and radon. Small solid infiltrating tumors received interstitial irradiation. Kilovoltages of 200, 400, and 1,000 were employed. With 200 kv. two to four portals were treated with a daily dose varying from 100 to 400 r.

Satisfactory results from irradiation were obtained in more than 50 per cent of the patients with papillary and papillary infiltrating carcinoma. In 13 of these cases the tumor disappeared entirely after external irradiation alone. In 44 patients, marked regression in size and number of the tumors was obtained, thus rendering the tumor susceptible to subsequent electrocoagulation, radon seed implantation, or both. In 24 patients, regression was only temporary. No response was obtained in 35 patients.

Of the 44 solid infiltrating carcinomas, only one responded favorably to roentgen therapy. Interstitial radon or surgery is recommended for these cases.

DAVID KIRSH, M.D.

**Multiple Carcinoma. Clinical Picture, Diagnosis and Prognosis.** Hugo Hellendall. *Am. J. Surg.* 60: 22-35, April 1943.

The clinical picture and diagnosis of multiple primary carcinoma, based upon 30 examples observed among 685 cancer autopsies at Presbyterian Hospital, New York, are discussed. In 21 cases the cancers were synchronous (occurring simultaneously); in 9 instances



metachronous, the second originating after operation for the first. In 24 of the 30 cases the digestive tract was the site of one of the tumors and in 11 the multiple cancers arose exclusively in the digestive tract.

Two or more primary cancers originating in different parts of the same organic system or in different organic systems will obviously produce very different effects than cancers occurring in the same organ. The formation of metastases, complications caused by the cancer, and independent diseases may change and influence the clinical picture. Analysis of the 30 cases observed brought out the fact that the period from the first appearance of symptoms until death was shorter in cases of multiple primary malignant growths than in single ones; the weight loss was also considerably greater. In 5 metachronous cases of multiple cancer, the duration of life was greater than in 5 corresponding synchronous cases. In 3 of the metachronous cases, the loss of weight was less than in corresponding synchronous cases.

The correct diagnosis of multiple cancer was made during life in 4 of the synchronous and in 5 of the metachronous cases of multiple cancer. The importance of a complete x-ray examination of the entire gastrointestinal tract is stressed. In several of the cases studied large gastric or duodenal tumors went unrecognized in the absence of x-ray studies.

Thirteen clinically observed cases of multiple cancer were also studied. Two patients with multiple synchronous cancers and three patients with cancers of the metachronous type were still living at the time of this report, but none was alive as long as five years after operation.

### NON-NEOPLASTIC DISEASE

**Minor Roentgen Therapy.** Sydney J. Hawley. *Pennsylvania M. J.* 46: 1278-1281, September 1943.

There is a tendency on the part of the general practitioner, and to some extent the radiologist, to forget that many non-cancerous ailments may be effectively treated by irradiation. Some of the more common conditions and techniques are enumerated.

*Lymphoid hyperplasia in the pharynx*, usually seen in children, less commonly in adults, causes deafness because of occlusion of the eustachian tubes. Such cases may be treated by 600 to 800 tissue r given in four to six applications over each side of the pharynx (200 kv. with 0.5 mm. Cu filter). About 20 per cent of cases require a second series in six months.

For *tuberculous cervical adenitis*, 100 to 200 tissue r are given once or twice a week for a total of 800 to 1,000 r. The voltage may vary from 100 to 200 kv. with from 0.5 to 1.0 mm. Cu. Resolution of the tuberculous lesions takes place in six to eight weeks. *Non-specific cervical adenitis*, which frequently is caused by tonsillar or dental infection, is treated with 100 tissue r on two successive days. Not more than four treatments should be given.

*Carbuncles and abscesses* are given 100 tissue r a day for not more than four treatments. *Furunculosis* is usually relieved by 100 tissue r every other day for six to eight treatments.

Patients suffering with *pertussis* are given 100 tissue r over the mediastinum through two portals, postero-anterior and anteroposterior, every other day for four treatments (200 kv., 0.5 mm. Cu). This treatment is not a specific but does decrease the cough.

*Hyperhidrosis* may be controlled by 100 tissue r at low voltage applied to the front and back of the hands and feet twice a week for three weeks.

*Verrucae* may be divided into four classes: (1) Warts of adolescence should not be treated, as they disappear spontaneously in a few months. (2) Warts at the edge of the nail should be well masked with lead and 2,500 r, measured in air, given at one sitting. The treatment is difficult by any method and in about half the cases recurrences are to be expected. (3) Plantar warts and (4) common warts not included in the other classes are treated by 1,500 r at one sitting, with low voltage.

*Corns and calluses* are treated by 1,000 to 2,000 r (low voltage) measured in air at one sitting, the adjacent skin being protected. One treatment is sufficient, but there will be a recurrence if the cause of the lesion—namely, tight or ill-fitting shoes—is not removed.

*Keloids and hypertrophic scars* are given 800 to 1,200 r in air (low voltage) at one sitting. This may be repeated once if regression does not occur.

JOSEPH T. DANZER, M.D.

**Roentgen Therapy of Laryngeal Tuberculosis.** Clarence W. Engler. *Ann. Otol., Rhin. & Laryng.* 52: 655-665, September 1943.

It is universally agreed that laryngeal tuberculosis is practically always secondary to pulmonary tuberculosis. Important factors in the healing process are the nature and extent of the pulmonary disease, a good general resistance on the part of the patient, and maintenance of body weight and appetite.

For the sake of simplicity the author uses the classification of Rickmann, who recognizes the following types:

1. "The productive or proliferative type. In this the lesion is fairly well defined and localized. Usually some degree of organization with a tendency toward healing is present.

2. "The exudative type. The lesions in this type are diffuse so that several structures, such as the vocal cords, the epiglottis, and the arytenoid areas, may be the seat of the disease at the same time.

3. "The mixed type. In this type both productive and exudative lesions exist in the same larynx. In all three types, infiltration and ulceration may be present."

There is no unanimity of opinion regarding the type of laryngeal lesion that will be improved by irradiation. It is the consensus that fractional doses give the best results and are safer than large doses, inasmuch as the dangers of cartilage necrosis and glottic edema are greatly lessened. After irradiation, sufficient regression may take place so that a previously hidden ulcer may come to view.

For the present series the physical factors employed consisted of 200 kv. potential; 0.75 mm. Cu plus 2.0 mm. Al filtration (H.V.L. of 0.9 mm. Cu); 50 cm. target-skin distance. Originally a dose of 100 r was administered to each side of the neck every ten days for ten treatments. Later the procedure was changed and only one side of the neck was irradiated with 150 r (measured in air) every ten days, the sides being alternated for a period of 200 days, or a total dosage of 1,500 r (150 r  $\times$  10) to each side. With a 20-ma. current, the output delivered was 35 r per minute. There was no instance in this series of radiodermatitis, and no patient exhibited skin erythema.

The cases receiving roentgen therapy were not



selected discriminately. In all, 38 patients were treated; some had the productive type, others the exudative, and a few the mixed type of tuberculosis. Healing of the larynx was secured in 8 cases, or 21 per cent; 6 cases, or 16 per cent, showed improvement in the condition of the larynx; in 8 cases, or 21 per cent, the laryngeal picture remained unchanged; in 16 cases, or 42 per cent, the disease became definitely worse.

Five of the 8 patients showing no change were treated with electrocautery either before or after the roentgen therapy was given. In none of them was any improvement obtained. All but one of these cases were of the exudative type.

The largest group of patients was that in which the condition became worse. In most of these, the pulmonary disease was of the active, progressive type, as confirmed by the fact that 12 of these patients died.

The laryngeal lesion may heal while the pulmonary disease progresses. In 3 of the 8 patients with healing of the larynx the lung condition became worse and of 6 with improvement of the laryngeal lesion 4 showed progression of the pulmonary disease. In a few cases the lung condition improved while the laryngeal lesion remained unimproved or progressed unfavorably.

From the material available one cannot determine the exact type of lesion that will be benefited by roentgen therapy nor can one say that it is superior to other local measures, such as electrocauterization.

STEPHEN N. TAGER, M.D.

**Some Observations on the X-Ray Treatment of Ankylosing Spondylitis.** Gwen Hilton. *Proc. Roy. Soc. Med.* 36: 608-610, September 1943.

The author reports the use of x-ray therapy for ankylosing spondylitis in 62 patients during the past three years. Roentgen classification according to location and extent of changes was discarded, since there was little relationship between the roentgen findings and the severity of the disease. In addition, the bony changes appear irreversible, so that x-ray re-examinations give no criteria of results from therapy. The series was therefore classified as to duration of symptoms.

The course of therapy to the sacro-iliac joints and vertebral column consisted of 18 treatments, but no details as to factors or dosage are given except that small "local" applications were used rather than the wide field or "bath" technic.

In the assessment of results only 47 patients treated more than six months before the time of the report are considered. Complete relief from pain was obtained in 7 patients and partial relief in 38 patients. As pain diminished, usually two weeks following the last treatment, movements of the spine became more free. In several cases, the course was repeated in six to eight months. The sedimentation rate usually became increased for some months despite symptomatic improvement. Best results were obtained when physiotherapy was combined with x-ray therapy.

LESTER M. J. FREEDMAN, M.D.

**Treatment of Cold Abscesses by Combined Surgical Drainage and Roentgen Therapy.** Alfredo Pavlovsky. *Radiologia* 6: 7-11, January-April 1943.

The author advises combined surgical drainage and roentgen irradiation for the treatment of cold abscesses. After surgical incision or emptying the abscess with the

aid of a trocar and cannula, the cavity, when possible, is packed with iodoform gauze and pockets are destroyed. The following factors are advised for roentgen therapy: 200 kv., 4 ma., 40 cm. distance, 1.5 mm. Cu plus 1.0 mm. Al filtration. For younger patients, those below thirteen years of age, the technic is modified as follows: 160 kv., 3 ma., 25 cm. distance, 0.2 mm. Cu plus 5.0 mm. Al filtration. The patient is given 200 r every other day for three doses, the treatment to be repeated in one month and, if found necessary, after another month.

Illustrative cases are presented. The author believes his results to be good.

A. MAYORAL, M.D.

**Roentgen Therapy in Ano-Vulvar Pruritus.** José Luis Molinari and Anibal Lemos Ibáñez. *Radiologia* 6: 19-21, January-April, 1943.

Although many gynecologists, internists, and surgeons condemn the method, the authors believe roentgen therapy to be of value in the treatment of ano-vulvar pruritus. They report excellent results in a review of 205 cases. The factors used are as follows: 100 kv., 4 ma., 25 to 50 cm. distance, 1.0 mm. Al filtration. Weekly doses of 200 r are given for 5 weeks. Sometimes smaller doses—400 to 600 r—have been sufficient to control the itching. In cases in which no relief is obtained, further treatment may be given after a three-month interval.

A. MAYORAL, M.D.

**Radio-Phosphorus. An Agent for the Satisfactory Treatment of Polycythemia and Its Associated Manifestations; Report of a Case of Polycythemia Secondary Possibly to the Banti's Syndrome.** Lowell A. Erf and Harold W. Jones. *Ann. Int. Med.* 19: 587-601, October 1943.

Polycythemia is a disease of unknown etiology characterized by a chronic course and a considerable increase in total blood volume over the normal, with an absolute increase in the total number of red blood cells and often of white blood cells and platelets.

A previous paper (*Ann. Int. Med.* 15: 276, 1941. *Abst. in Radiology* 39: 645, 1942) reported marked clinical and hematological improvement in 6 cases of polycythemia following administration of radiophosphorus. Those 6 patients have been maintained in essentially complete clinical and hematological remissions for nearly two years. Eleven additional cases are now recorded.

All of the radioactive phosphorus solutions were injected intravenously. In the majority of cases the total dosage was between 7 and 11 millicuries. The first significant hematological responses occurred about 60 to 100 days after the first injection.

Of the 11 patients, 6 were white males (2 Russian Hebrews), 4 were white females, and 1 was a colored female. Each patient had had polycythemia from two to eight years before therapy with radiophosphorus was instituted, and all had received many types of therapy, such as roentgen irradiation, ultraviolet irradiation to skin or to auto-transfused blood, Fowler's solution, phenylhydrazine, venesection, etc., but in none did satisfactory remissions follow such treatments. None had been treated with lead compounds or spray roentgen therapy. The symptoms varied widely: some were cerebral or spinal in character, such as lethargy, dizziness, staggering (multiple sclerosis syndrome), and incontinence; some were referable to the gastro-intes-

tinal tract (symptoms of duodenal and stomach ulcers, gastric bleeding); others to the vascular system (tender congested toes, thromboses, varicosities, prolonged bleeding tendencies), the cutaneous system (eczema, acne urticata, indolent leg ulcers), the osseous system (arthritis), the urinary system (bloody urine), and the reticulo-endothelial system (splenic infarcts).

The clinical and hematological findings in the 11 cases before and after administration of radiophosphorus are presented in comprehensive tabular form. Sternal marrow studies were made in 8 patients before and in 8 after treatment, and these also are tabulated.

After treatment with radiophosphorus, the patients usually showed a gain in weight, good appetite, and clinical and hematologic remission. The coagulation time of polycythemic blood is abnormally prolonged, and patients bleed readily following minor cuts. This symptom also disappeared. The authors suggest that the mechanism of the radiophosphorus effect may be similar to that of "spray" roentgen therapy, which is said to produce excellent remissions. Radiophosphorus is concentrated in the bone marrow, continuously bombarding this for days. Both radiophosphorus and roentgen radiation probably decrease red cell production by retarding mitosis of normoblasts in early prophase. In both types of treatment the period of irradiation (by beta particles) is prolonged, which may be an effective factor.

A full history of a case in which the microscopic findings were suggestive of Banti's disease is appended.

## EFFECTS OF RADIATION

**Metabolic Changes Occurring as the Result of Deep Roentgen Therapy: I. Effect of 200 Kilovolt Roentgen Therapy.** Douglas Goldman. *Am. J. Roentgenol.* 50: 381-391, September 1943.

The investigation described here was undertaken with the idea of determining what changes in the body economy result from deep roentgen therapy (200 kv.), especially in relation to the symptom complex known as "irradiation sickness" and in relation to the wave length of radiations. The patients observed were on constant, accurately weighed diets, potentially neutral, low in purines and calcium, and in most instances minimal in chloride. Analyses of urine, feces, and vomitus, if any, were made for inorganic constituents. Nitrogen, uric acid, and other components of the nitrogen partition were determined on the urine only.

Changes in the excretion of total nitrogen and its components are the most definite deviations from the control values presented by the investigations. There was, in general, an increase in the urinary output of total nitrogen either during the periods when radiation was being given or immediately following cessation of the treatment. Nitrogen loss was greater in patients with radiosensitive tumors. Both uric acid and, to a lesser degree, ammonia were found to be involved in this nitrogen increase. The total acid of the urine was definitely higher in most cases during or after roentgen therapy, probably the result of greater destruction of body protein. A slight diminution in amino-acid nitrogen excretion took place two to six days after irradiation and continued to the end of the observations. This seems to indicate a storage of nitrogen after the primary destructive effect of irradiation had worn off.

No significant deviation of the calcium balance from

control values was observed. Increase in the urinary phosphorus output was found during or following roentgen therapy with deviation of the balance to the negative side. A small but definite increase in the urinary sulfur and sulfate occurred following irradiation. All of the patients who became severely ill showed a definite chloride loss during the irradiation period. The chloride balance became positive shortly before or simultaneously with improvement in symptoms. Sodium chloride by mouth is very frequently an effective therapeutic agent in irradiation sickness. In some cases its action was dramatic. There is a definite susceptibility to roentgen sickness of patients with protracted sodium chloride starvation.

CLARENCE E. WEAVER, M.D.

**Metabolic Changes Occurring as the Result of Deep Roentgen Therapy: II. Effect of 1,000 Kilovolt Roentgen Therapy.** James E. Robertson. *Am. J. Roentgenol.* 50: 392-399, September 1943.

Seven patients were subjected to a careful study of nitrogen and chloride metabolism before, during, and after 1,000-kv. roentgen therapy. The results proved to be similar to the results of the study conducted in the same laboratories on the effect of 200-kv. roentgen therapy (see preceding abstract). Supervoltage roentgen radiation was shown to produce an increased excretion of nitrogen, uric acid, and chloride in some of the patients, just as does radiation of lower voltage. That the negative nitrogen balance results entirely from tissue destruction is strongly indicated by its restriction to cases in which large tumors disappear under the influence of roentgen radiation. In all cases in which study was sufficiently prolonged, a period of nitrogen storage followed that of nitrogen loss.

Chloride metabolism changes in the nature of a negative chloride balance were demonstrated, but less frequently in the patients receiving the 1,000- than the 200-kv. therapy. Though the chloride change seems to be correlated with the degree of nausea and vomiting, this study suggests that it is a secondary result of a disturbance in water balance rather than the precipitating cause of the roentgen sickness. Roentgen sickness was observed much less frequently under million-volt roentgen therapy than under 200,000-volt roentgen therapy. No significant differences in changes in metabolism induced by irradiation with 200-kv. and 1,000-kv. roentgen rays were demonstrated.

CLARENCE E. WEAVER, M.D.

**Radiodermatitis of the Head and Neck with a Discussion of Its Surgical Treatment.** F. A. Figi, G. B. New, and C. R. Dix. *Surg., Gynec. & Obst.* 77: 284-294, September 1943.

Serious damage to the skin may follow the use of radium or roentgen rays even when relatively small dosage is given, but the hazards of such treatment are well known, and prophylactic measures are reducing the incidence of such lesions. The total dosage and factors of application are chiefly responsible for the tissue reactions, but exposure to sunlight or other rays, and chronic irritation of various sorts, combined with the inherent sensitivity of the skin itself, play a part in the production of irradiation dermatitis. Numerous extensive lesions have followed use of roentgen rays by beauty shop operators for depilatory purposes. Other cases have followed repeated

cations of roentgen rays or radium to angiomas of the "port wine" type, which are notoriously radioresistant. Among physicians, dentists, and technicians, who constantly use radiation, lack of proper appreciation of the dangers involved, and perhaps lack of proper protection, has led to serious skin injury. In spite of the danger to both patient and administrator, the results obtained well justify this form of treatment.

Radiodermatitis may be acute or chronic, mild or severe. The acute form is comparable to the three stages of ordinary burns, except that healing progresses much more slowly. A dusky blue erythema is noted at the end of two weeks, and either dry or exudative dermatitis at the end of three weeks, often followed by increased pigmentation and loss of hair, and rarely by final loss of all pigment. The destructive effect of irradiation is greatest in a central area, decreasing gradually toward the periphery of the exposed field, leaving at times no clear line of demarcation between devitalized and healthy tissues. Necrosis, sloughing, and secondary infection may occur, which require weeks or months for healing, with the ever present danger of another breakdown of the central area months or even years later. Except in the mildest reactions, some secondary skin changes are certain to appear, occasionally after a lapse of years.

The chronic form follows the acute reaction after a latent period of one to ten years, during which there may be no visible skin changes. Occasionally the chronic form may be produced by repeated small exposures. In this stage marked skin changes take place, with dryness, fissuring, telangiectasia and atrophy of the surface, with loss of glands and hair follicles, so that the skin assumes a smooth, dry, glistening appearance. Keratoses, sclerosis, and induration develop later, and the skin becomes thick, leathery, and immobile. Skin atrophy and vascular obliteration lead to necrosis and sloughing, and deep ulcers may form, with thick, indurated edges and a necrotic base fixed to the underlying structures. In the region of the head and neck perforation into the mouth, nose, larynx, or trachea may occur. The ulcerations are extremely indolent and show little or no tendency to heal. Secondary infection takes place, with pocketing of purulent material. Intense itching and intractable pain are additional unpleasant complications.

Malignant changes, usually epitheliomas of the squamous-cell type, may develop in the keratoses and persistent ulcers after a latent period of months or years. The incidence of malignant changes in the groups mentioned by the authors varied from 10 to 19 per cent. The malignant activity of these lesions is usually moderate or of low grade, but fulminating types may appear. The large amount of sclerosis present in these lesions retards the occurrence of metastases, and treatment carried out promptly after the appearance of the malignant process offers a satisfactory prognosis.

Because of the sclerosis and ulceration, contractures may be present, but because keloids are absent, they occur less commonly than in burns from either heat or caustics. Located near the eyelids, lips or nostrils, contractures may constitute the most serious factor of the condition.

The pathological tissue changes in radiodermatitis produced by either roentgen rays or radium are (1) destruction of hair follicles, sweat and sebaceous glands; (2) replacement of normal collagen by a dense hyaline collagen rich in elastic and cellular tissue; (3)

obliteration of the smaller blood vessels in the corium and subcutaneous tissue, and thickening of the walls of the larger vessels; (4) necrosis and rarefaction of the corium with thrombosed areas of telangiectasia; (5) reparative proliferation and hypertrophy of the epidermis.

Unless damage to the tissues has been unusually severe, the acute reaction is self-limited and runs its course of weeks or months regardless of the treatment given. Soothing ointments, drying lotions, sulfathiazole powder, solutions of acriflavine and gentian violet, or warm moist compresses may palliate the condition and combat the infection and acute inflammation. Radical measures are contraindicated at this time because of the sloughing and infection; they tend to aggravate the condition and prolong healing.

The treatment of chronic radiodermatitis depends on the extent and severity of the damage, the presence of malignant change, and the age and general condition of the patient. When sclerosis, atrophy, and hyperkeratoses are pronounced, with ulcerations, only surgical treatment is likely to afford relief. If the lesion has undergone malignant change, surgery is imperative. This consists of removal of the diseased tissues and repair of the resultant defect. In the presence of infection, necrosis, or extensive malignant changes, it is preferable to leave the wound open and defer repair until a later date. Examination of frozen sections may warrant immediate plastic repair in many suspected cases. Whether the wound is left open or not, excision of the process usually affords immediate relief of the distressing symptoms, relaxes contractures if present, offers immediate opportunity for histological study, and prepares a graft bed with a greatly improved blood supply. Excision must extend well beyond the region of marked tissue change, even at the expense of relatively important structures. Because of the extremely slow rate of sequestrum formation in irradiation necrosis, affected bone should be removed well into freely bleeding territory. Soft-tissue excision need not extend beyond the region of sclerosis and telangiectasia. Use of the electrocoagulation scalpel is recommended because of the easier control of vascular oozing and because a graft will usually take readily on a surface so prepared.

The method of repair depends on the location and extent of the lesion and the malignant changes present. Removal with simple primary suturing of the undercut edges may be possible. Multiple partial excisions, with intervening periods for healing and relaxation of the tissues, if feasible, permit wide removal without distortion and only linear scarring. Wide involvement about fixed points, such as the nose and ears, usually requires free skin grafts or pedicle flaps. In these cases, if superficial ulceration and considerable inflammatory reaction are present, it may be advisable to apply thin shaved grafts; after these have healed and the inflammation has disappeared, full-thickness skin grafts or pedicle flaps may be used to recover the surface. Full-thickness skin grafts contract little, are more resistant to trauma, and present a better cosmetic appearance than thin grafts. They should not be used in the presence of infection nor in areas which cannot be protected from contamination or which cannot be immobilized. With deep involvement some type of pedicle flap is indicated, which is usually prepared in advance of the excision and transferred to the fresh wound only when ready for it. Tubed pedicle flaps are

often desirable in cases of extensive radiodermatitis about the lower face or neck.

The authors state that surgical treatment of radiodermatitis is highly satisfactory as regards relief of symptoms, correction of deformities, and restoration

of function. Surgical removal of neoplasms developing in areas of irradiation dermatitis, because of their slow rate of metastasis, offers an excellent chance of cure if done at a reasonably early stage.

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## EXPERIMENTAL STUDIES

**Effects of Roentgen Rays on Cell-Virus Associations. Findings with Virus-Induced Rabbit Papillomas and Fibromas.** Wm. F. Friedewald and Rubert S. Anderson. *J. Exper. Med.* 78: 285-303, October 1943.

Experiments reported in detail by the authors were undertaken (1) to study the possible quantitative changes in the amount of virus associated with living papilloma cells under the effect of x-ray irradiation; (2) to determine whether a variant of the virus could be produced by irradiation. The viruses causing the papillomas of domestic and cottontail rabbits, and also the infectious fibromatosis of rabbits, were subjected to comparable experiments.

The virus-induced papillomas of cottontail and domestic rabbits regress completely within a few weeks when exposed to 5,000 r of x-ray radiation. The associated virus persists in undiminished amounts during regression and often an increased yield can be obtained on extraction. The increased yield suggests several possibilities.

1. The cells are so altered by x-ray as to favor rapid multiplication of the virus. Against this are the observations: (a) that an increased yield of virus was found in papillomas removed within an hour after irradiation; (b) that the papilloma virus is extremely resistant, retaining its activity well in keratinized tissue, yet no increase in the amount of it was found when the growths had been removed several days after irradiation.

2. X-rays cause a temporary change in virus-cell relationship such that more virus comes away on extraction—a possibility that is more likely.

The fibroma virus in crude extracts or *in vivo* is inactivated by far less radiation than the papilloma virus. Ten thousand r destroy 90 per cent or more of the infectivity of the fibroma virus, whereas at least 100,000 r are required to inactivate 50 per cent of the papilloma virus in extracts containing about the same amount of protein. The greater sensitivity of the fibroma virus is possibly explained by particle size. The volume of the fibroma virus particle has been shown to be 25 to 50 times greater than the volume of the papilloma virus particle. Furthermore, extraneous protein reduces the indirect water reaction of x-rays.

No variant of the papilloma virus or fibroma virus has been encountered as a result of the irradiation.

SIDNEY LARSON, M.D.

**Radioactive Phosphate as an Indicator of the Relationship Between the Phosphate Changes of Blood, Muscle and Liver, Following the Administration of Insulin.** Nathan O. Kaplan and David M. Greenberg. *Am. J. Physiol.* 140: 598-602, January 1944.

The changes in the phosphates of blood, muscle, and liver produced by insulin were studied by means of tracer experiments with radioactive phosphate.

Insulin caused an increase in the total acid soluble  $P^{32}$  of the liver and muscle; an increase in the total

acid soluble  $P^{31}$  was noted only in the liver. The rate of disappearance of inorganic  $P^{32}$  from blood was accelerated by insulin.

Insulin induced a rise in the  $P^{31}$  and  $P^{32}$  of the barium-soluble fraction of blood, muscle, and liver. The specific activity of this fraction was increased in muscle and liver but not in blood. The rise in the barium-soluble fraction in the blood is believed probably to be due to an increased esterification of glucose. In the muscle the increase mainly represents newly synthesized hexose monophosphate. The barium-soluble fraction of the liver contains very little hexose monophosphate; the main component may be glycerol phosphate.

Evidence is presented which indicates that insulin produces similar effects in blood, muscle, and liver.

**A Study with Radioactive Isotopes of the Permeability of the Blood-Cerebrospinal Fluid Barrier to Ions.** David M. Greenberg, *et al.* *Am. J. Physiol.* 140: 47-64, October 1943.

This paper reports another application of radioactive isotopes to the investigation of physiologic problems. The authors studied the permeability of the blood-cerebrospinal fluid barrier to ions and report their findings in considerable detail.

**Elimination of Administered Zinc in Pancreatic Juice, Duodenal Juice, and Bile of the Dog as Measured by Its Active Isotope ( $Zn^{65}$ ).** M. Laurence Montgomery, G. E. Sheline, and I. L. Chaikoff. *J. Exper. Med.* 78: 151-159, September 1943.

The authors, using dogs prepared with pancreatic, biliary and duodenal fistulae, measured by means of the Geiger counter the amount of radiozinc in the secretion after injecting intravenously zinc chloride containing  $Zn^{65}$ . Radiozinc appeared in the secretions of the pancreas within thirty minutes after intravenous injection of the labeled zinc. Radiozinc practically disappeared from the plasma in forty-eight hours, yet was excreted from the pancreas as long as fourteen days. A large proportion of injected radiozinc is eliminated by way of the external secretion of the pancreas—as much as 11 per cent in fourteen days.

Very little radiozinc appears in the bile, the maximum excretion being 0.4 per cent in eight days.

Radiozinc was found in large amounts in the duodenal juice from an isolated loop of duodenum. In view, however, of large amounts of the substance found in the sediment of duodenal juice, conclusions regarding the significance of duodenal secretions in the elimination of zinc should be withheld for the present.

The authors believe that pancreatic juice is a normal excretory pathway for zinc. The high concentration of radiozinc in the pancreatic juice, compared with the low concentrations in the plasma, indicates that the acinar cell concentrates zinc.

SIDNEY LARSON, M.D.

## ABSTRACTS OF CURRENT LITERATURE

## RADIOLOGIC SERVICES: GENERAL CONSIDERATIONS

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**The Future.** Radiological Services. South African M. J. 17: 327-329, Nov. 13, 1943.

The Radiological Society of South Africa distributed a questionnaire to 43 radiologists in the Union of South Africa and from 27 replies prepared a report on Radiological Services which it presented to the National Health Services Commission.

The recommendations for Diagnostic Radiology include the following:

**Staff:** Subject to war conditions, radiographs should be made by qualified radiographers (technicians) specially trained. They should not be permitted to do any x-ray screening (fluoroscopy) or to attempt diagnosis. In small hospitals and clinics, where no radiologist is available, simple interpretations may be made by general practitioners. Cases demanding detailed study should be referred to larger institutions where qualified radiologists are available. In large hospitals, a radiologist should be appointed on a full-time basis. Wide experience in large clinics should have more weight than degrees or diplomas. Certain specialists, e.g., those in urology, orthopedic surgery, cardiology, etc., may undertake film interpretation in their departments but close co-operation with the radiologist should always exist.

**Research:** Technical research may be left to the physicists, chemists, and engineers of the equipment manufacturers. Development of diagnostic methods is best produced by radiologists and other physicians.

**Education:** Instruction of the medical student should not be confined to a set number of lectures but should extend throughout his entire clinical training as the opportunity arises, under competent instructors. Postgraduate training for radiologists should be available. This has already been begun at the University of Cape Town in preparation for the Diploma of Radiology at that university.

**Economics:** "If private practice continues to play an important part in the medical services of this country for some time to come, it becomes necessary to examine the bearing which it will have on the organization of public (that is, national health services) x-ray diagnostic services." Large and medium-sized hospitals should have full-time radiologists, barred from receiving private fees. If part-time officials are appointed, they should be entitled to fees for work done on paying patients. The majority of the radiologists voted in favor of the percentage fee system, but it is felt that this may not be compatible with the desire of the medical profession that the hospital should make no profit on professional services, on the one hand, and not compete with private practitioners by charging

lower fees, on the other. The system in use at the Groote Schuur Hospital (Cape Town), where the institution charges for technical service and the radiologist renders his fee directly to the patient, is suggested.

The following recommendations are made for Therapeutic Radiology:

**General:** No radiotherapy should be done in small hospitals or communities, with the exception of special skin clinics.

**Staff:** With the exception of dermatologists, radiotherapy should be practised by specifically trained radiologists alone. Qualifications should include personal character and energy, special knowledge of physics and biology, wide clinical knowledge of surgery, gynecology and especially malignant tumors, and experience in or an aptitude for research.

**Organization:** Radiotherapeutic service should be arranged for treatment of certain conditions in medium-sized hospitals. The annual deaths from cancer among Europeans in the Union of South Africa and in Great Britain are about the same, namely, 14 per cent of all deaths. In Great Britain, the current assumption is 2,000 new cases per million population per year, of which 1,000 are suitable for treatment. On the basis of four weeks' hospitalization, the British Radium Commission recommends 75 beds for this number of cases. The required bed capacity for the Union of South Africa is estimated at 300 beds for Europeans and 360 beds for non-Europeans. Suggestions are given for distribution of these beds.

**Research (Cancer) Institute:** Unlike research in diagnosis, which is carried on as an integral part of other specialties, radiotherapeutic research is a special branch in its own right. A special institute devoted to the development of radiotherapy and the research required for its growth is essential. It is suggested that 60 of the 660 beds required for treatment be assigned to a state-aided Cancer Institute.

**Education:** Radiotherapy should be stressed to a greater degree in the medical schools.

**Economics:** Remuneration schedules should be similar to those for diagnostic radiologists. The centralization of treatment centers makes transportation problems a prime consideration. Hospital Social Service should be organized to issue transportation warrants for patients needing treatment, as well as for follow-up examinations. Other social and economic hardships could be alleviated by an efficient Social Service.

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